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Figure 1. Microwave Field Intensity Meter

SECTION A
GENERAL DESCRIPTION

1. SCOPE OF HANDBOOK.

This preliminary handbook contains descriptive material and instructions for the installation and operation of the Model FIM Microwave Field Intensity Meter. The equipment is designed and manufactured by Polarad Electronics Corporation, Long Island City, New York.

2. PURPOSE AND BASIC PRINCIPLES. (See figure 1.)

a. The Model FIM Microwave Field Intensity Meter (hereafter called the FIM) is a highly sensitive triple conversion microwave superheterodyne receiver, designed for locating and measuring rf interference and making field intensity measurements in the frequency range of 1.00 kmc to 10.00 kmc. The equipment is basically a selective voltmeter, with sufficient sensitivity to measure rf interference or the intensity of radiated rf signals.

b. The FIM consists of a Monitor Unit (Model FIM-B), four plug-in Tuning Units (Models FIM-L, -S, -M, -X), a Power Unit (Model FIM-P), and five antennas for interference or signal pickup. Other accessory components necessary for proper interconnection and operation of the equipment are illustrated in figure 1. The overall dimensions and weights of the equipment are listed in table I.

c. Quantitative measurements of the intensity and frequency of radio signals or interference can be made by use of the equipment. Measurements can be made in terms of the average, quasi-peak, or peak value of the signal or interference. This facility is provided by a calibrated meter and function selector, located on the Monitor Unit front panel. The function selector provides for the measurement of the peak value of a signal in its PEAK position, the weighted value in its QUASI-

PEAK position, and the average value in its AVERAGE position.

(1) In addition to providing circuitry for calibrating or standardizing its gain for precalibrated measurements techniques, the Monitor Unit also provides a means of accurately measuring the average value of a signal by a direct signal substitution method. These functions are accomplished when an additional function switch, on the front panel of the Monitor Unit, is rotated to its CAL. -SIG. GEN. position.

(2) To facilitate detection of unmodulated signals, an audio frequency oscillator is included in the Monitor Unit circuitry. The audio frequency oscillator is energized when the AURAL TUNING AID control is rotated clockwise beyond its off position. The 1,000-cps output of this oscillator is used to modulate the incoming signal during its second frequency conversion at the crystal mixer stage in the preamplifier circuit. By this means, the signal can be more easily detected and monitored with a pair of headphones connected to the AUDIO OUT telephone jack.

d. The FIM can be used for radio interference surveys and to determine the source and magnitude of radiated or conducted interference within the frequency range of 1.00 kmc to 10.00 kmc. The equipment can also be used for field intensity measurement surveys, for adjusting directive antennas, exploring radiation patterns, i-f attenuator measurements, swr measurements, insertion loss etc. where field intensity may vary over a wide range of values.

TABLE I. EQUIPMENT SUPPLIED

Component	Overall Dimensions			Weight
	Height	Width	Depth	
Monitor Unit, Model FIM-B *	23-1/2	17-13/16	21-1/2	70
Band 1 Tuning Unit, Model FIM-L	16	17-3/8	14-1/2	50
Band 2 Tuning Unit, Model FIM-S	16	17-3/8	14-1/2	50
Band 3 Tuning Unit, Model FIM-M	16	17-3/8	14-1/2	50
Band 4 Tuning Unit, Model FIM-X	16	17-3/8	14-1/2	50
Power Unit, Model FIM-P	19-13/16	16-5/32	25-1/2	115
Omnidirectional Antenna, Model CA-B	9-3/16	9-3/16	10-19/32	2.5
Band 1 Directive Antenna, Model CA-L	13-3/4	9-7/16	5	2
Band 2 Directive Antenna, Model CA-S	13-29/32	10-1/2	17-11/16	3.5
Band 3 Feed Horn, Model CA-M	1-15/16	2-1/4	3-1/4	0.5
Band 4 Feed Horn, Model CA-X	1-5/8	1-15/32	3-1/8	0.5
Antenna Reflector, Model CA-R	20-13/16	19-15/16	13-3/16	2
Tripod, Model CA-T	36-1/2	5	5	5
6-ft. Rf Cable	-	6 ft.	-	1
Interconnecting Cable No. 1	-	8 ft.	-	2.5
Interconnecting Cable No. 2	-	4-3/4	-	0.25
Interconnecting Cable No. 3	-	8"	-	0.3
Power Cable	-	10 ft.	-	1.5
Wrench Kit				

Unless otherwise designated, dimensions are in inches, weights are in pounds.

*Size includes one tuning unit.

3. DESCRIPTION OF MAJOR UNITS.

a. MONITOR UNIT, MODEL FIM-B. (See figure 1.)

(1) The Monitor Unit is the control and metering unit of the FIM. The hammertone green, smooth-finished case of the unit is equipped with ventilating louvers at the sides and top. The front panel serves as a mounting for the meters, operating controls, and indicating devices. The bottom section of the Monitor Unit has a large panel opening which is designed to accept one of the Tuning Units into the frame.

(2) The Monitor Unit contains the following components:

(a) An i-f amplifier chassis;

(b) A crystal-controlled local oscillator chassis;

(c) An afc chassis;

(d) An i-f preamplifier chassis;

(e) Video, audio, metering, and detector weighting circuits;

(f) An electrically operated rf coaxial switch;

(g) Two electrically operated rf coaxial turrets;

(h) An electrically operated i-f attenuator transfer switch.

b. RF TUNING UNITS, MODELS FIM-L, -S, -M, -X. (See figure 2.)

(1) Four Rf Tuning Units are provided to cover the entire frequency range of the equipment. The operating range of each unit is listed in table II.

TABLE II. TUNING UNIT FREQUENCY RANGES

Tuning Unit	Frequency Coverage in Kmc
Band 1	1.00 to 2.24
Band 2	2.14 to 4.34
Band 3	4.20 to 7.74
Band 4	7.36 to 10.00

Figure 2. Typical Rf Tuning Unit and Monitor Unit

(2) Each Tuning Unit provides single-dial direct-reading, continuous-frequency tuning with automatically tracked repeller voltages. For proper operation, the Tuning Unit covering the desired frequency range is inserted into the Monitor Unit frame. Two handles and four quarter-turn fasteners on the front panel of each Tuning Unit permit convenient insertion into, and removal of the component from, the frame.

(3) Each Tuning Unit includes the following components:

(a) A preselector;

(b) A crystal mixer;

(c) A klystron local oscillator;

(d) A klystron oscillator signal calibrator;

(e) A manually-operated gear-drive system;

(f) Two repeller voltage-tracking potentiometers;

(g) In the Tuning Units covering Bands 1 and 4, two microswitches, one of which is dual, and the other a single type; Bands 2 and 3 do not use mode switching.

(h) A repeller voltage trimmer potentiometer, for the signal calibrator;

(i) A coarse tuning control, for the signal calibrator;

(j) An amplifier, for the afc circuit.

c. POWER UNIT, MODEL FIM-P. (See figure 3.) The Power Unit contains all the necessary high and low voltage supplies for proper operation of the equipment. The bias, low voltage, repeller, and beam voltages can be monitored by means of a front panel selector switch and meter. The klystron local oscillator

Figure 3. Power Unit, Model FIM-P, with Dust Cover

and signal calibrator beam currents can also be monitored by another front panel selector switch and meter. Screwdriver adjustment potentiometers, for adjusting the beam, repeller, and low voltages, are available on the front panel. A removable aluminum-mesh blower filter is located in the central portion of the front panel Ease in handling and carrying the unit is permitted by use of the front panel handles. The unit is completely enclosed with a louvered dust cover.

d. ANTENNAS. (See figure 1.)

(1) Omnidirectional Antenna. One conical omnidirectional antenna is supplied. This antenna covers the entire frequency range of the instrument, and may be used with any one of the four Tuning Units supplied. The antenna may be operated as a vertical or horizontal linearly polarized pickup device. Its nominal input impedance is 50 ohms. (See figure 4.)

(2) Directive Antennas. A separate directive antenna is supplied for each of the four Tuning Units. The antennas for use with Bands 1 and 2 Tuning Units are of the horn type; those for use with Bands 3 and 4 Tuning Units are horn-fed parabolic assemblies. One parabolic reflector is supplied for use with either the Band 3 or Band 4 feed horn, as illustrated in figure 1.

(3) Mounting Facilities. All antennas supplied are equipped with brackets for attachment to the antenna tripod. Either vertical or horizontal polarization may be selected, depending on the orientation of the mounting bracket. Each bracket also serves as a mounting for the antenna rf cable connector.

e. TRIPOD. (See figure 5.) The antenna tripod mounting plate permits complete 360° rotation in azimuth and 180° change in elevation. Locking can be accomplished in any position by means of two locking levers. Protractor scales

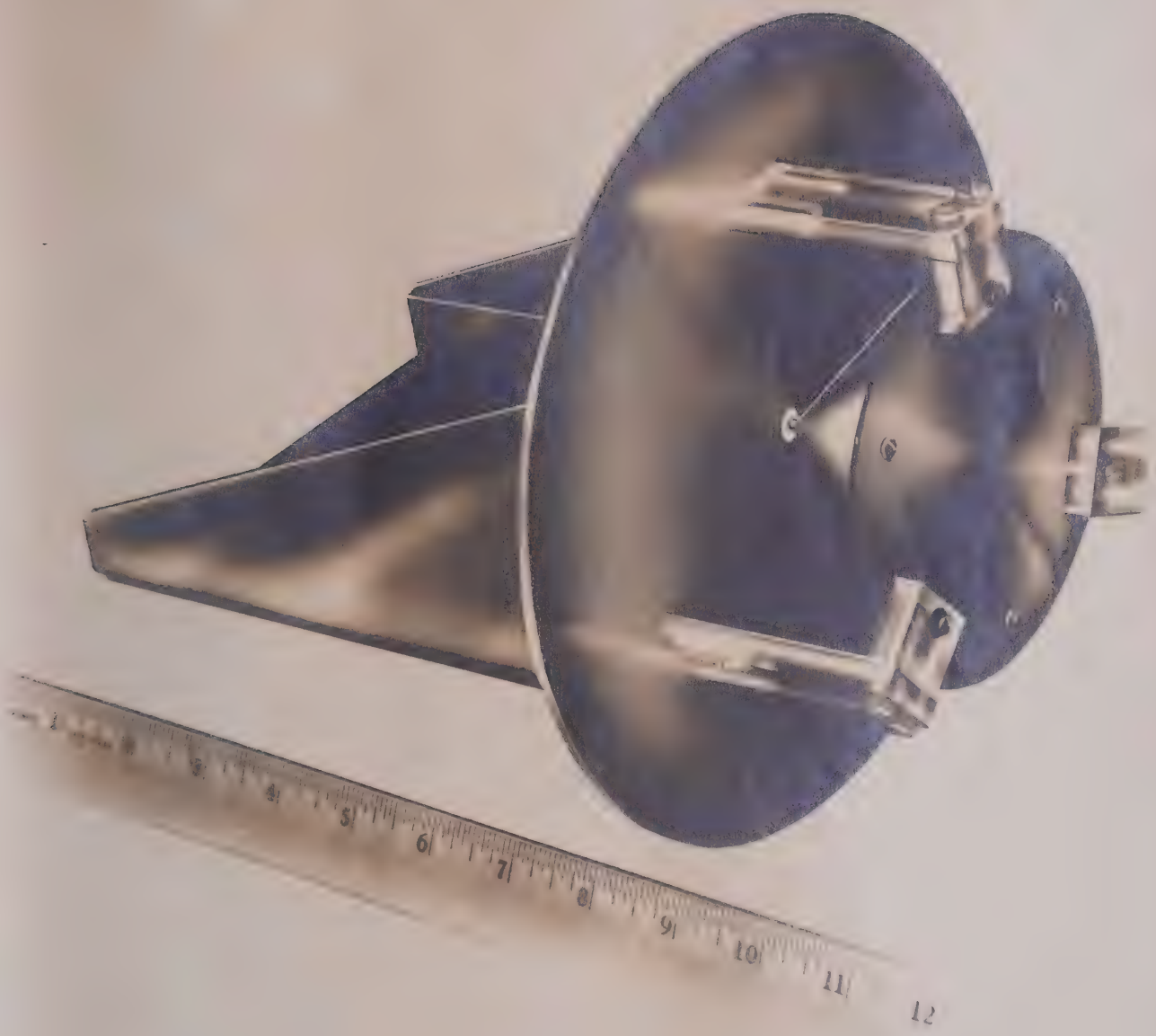


Figure 4. Omnidirectional Antenna, Model CA-B

Figure 5. Antenna Tripod, Model CA-T

provide accurate determination of the antenna elevation and azimuth. A star-shaped knob just below the mounting plate permits screw attachment to the antenna brackets. The tripod legs are of fungus-treated wood and can be extended, by means of two fluted knobs for each leg, from 36-1/2 inches to a full 60 inches. Screw-type tips at the leg ends permit interchanging of rubber tips (when the tripod is used indoors) and metal tips (when the tripod is used in the field).

f. ACCESSORY CABLES. (See figure 1.) Five cables are supplied with the equipment.

(1) A six-foot coaxial rf cable is used to connect the incoming signal to the Monitor Unit.

(2) An eight-foot cable is used to connect the Power Unit to the Monitor Unit.

(3) A 10-foot cable is used as the primary power input cable, for connecting the Power Unit to the primary power source.

(4) A cable 4-3/4 inches long interconnects the 140 MC IN jack and the 140 MC OUT jack, both of which are located on the Monitor Unit front panel.

(5) An eight inch cable is used to connect the SIG. GEN. OUT jack (Tuning Unit) to the CAL. IN jack (Monitor Unit).

4. TECHNICAL CHARACTERISTICS.

Frequency range . . . . . 1.00 to 10.00 kmc in four bands:

Band 1: 1.00 to 2.24 kmc,
Band 2: 2.14 to 4.34 kmc,
Band 3: 4.20 to 7.74 kmc,
Band 4: 7.36 to 10.00 kmc.

Frequency calibration accuracy. . . . . Better than ±1 percent.

Type receiver	Triple-conversion superheterodyne.
Input rf voltage range	20 microvolts to 3 volts.
Input impedance	50 ohms nominal.
Bandwidth	5.0 mc ±0.5 mc at -6 db.
Impulse bandwidth	5.0 mc.
Image and spurious response rejection	Better than 60 db.
Signal attenuation range	80 db maximum; Rf: 0 to 60 db in steps of 20 db; I-f: 20 db.
Intermediate frequencies	First: 260 mc; Second: 140 mc; Third: 40 mc.
Weighting circuit time constants:	
For average and peak measurements	Charge time constant: 0.1 microsecond ±0.05 microsecond; Discharge time constant: 0.3 microsecond ±0.03 microsecond.
For quasi-peak measurements	Charge time constant: 50 microseconds ±10 microseconds; Discharge time constant: 500 milliseconds ±100 milliseconds.
Audio output	100 milliwatts minimum into 600 ohms.
Video output	0.5 volt minimum into 2 megohms.
Recorder	0 - 1 milliampere recorder, 1500 ohms.
Calibration signal (cw)	0.2 volts rms to 5 microvolts, 0 to -95 dbm.
Power requirements	115 volts ac ±10 percent, 50 - 450 cps, single phase, 700 watts.

5. SERIES OF REFERENCE SYMBOL NUMBERS.

Table III shows the blocks of reference symbol numbers assigned to each major component of the equipment.

TABLE III. REFERENCE SYMBOL NUMBERS EMPLOYED

Major Component	Series of Reference Symbols
Monitor Unit, Model FIM-B	1 - 199
Power Unit, Model FIM-P	201 - 399
Band 1 Rf Tuning Unit, Model FIM-L	401 - 499
Band 2 Rf Tuning Unit, Model FIM-S	501 - 599
Band 3 Rf Tuning Unit, Model FIM-M	601 - 699
Band 4 Rf Tuning Unit, Model FIM-X	701 - 799
Preamplifier	801 - 899
Accessories	901 - 999

6. ELECTRON TUBE, FUSE, AND LAMP COMPLEMENT.

Table IV lists in numerical order the types and reference symbols involved of the entire complement of electron tubes used in the major components of the FIM. Table V is a listing of the fuses and indicator lamps supplied.

TABLE IV. ELECTRON TUBE COMPLEMENT

Electron Tube Type	Symbols Involved	Monitor Unit	Band 1 Tuning Unit	Band 2 Tuning Unit	Band 3 Tuning Unit	Band 4 Tuning Unit	Power Unit	Qty per Equip.
0A2	V216						1	1
0B2	V215, V222, V224						3	3
5R4WGA	V201, V202, V208, V209. V217, V218						6	6
6AN5	V8	1						1
6AU6	V11, V12, V15, V16, V22, V223, V405, V505, V605, V705	5	1	1	1	1	1	10
6X4	V219, V403, V404, V503, V504, V603, V604, V703, V704		2	2	2	2	1	9
12AT7	V10, V17, V21	3						3
5814	V25	1						1
0A3/VR75	V204, V205, V213, V214						4	4
6AK5	V1, V2, V3, V4, V5, V6, V7, V13, V14, V18, V19, V20	12						12
5721 or 6390	V701, V702 V601 V602				2	2		4

TABLE IV. ELECTRON TUBE COMPLEMENT (Cont'd)

Electron Tube Type	Symbols Involved	Monitor Unit	Band 1 Tuning Unit	Band 2 Tuning Unit	Band 3 Tuning Unit	Band 4 Tuning Unit	Power Unit	Qty per Equip.
5722	V207						1	1
6AL5	V9	1						1
5751	V206, V212						2	2
583[illegible] or 6BL6 or ZV1009	V502			1				1
5836	V501			1				1
5837 or 6BM6	V402		1					1
5837	V401		1					1
5876	V801, V802	2						2
5933	V203						1	1
6AQ5	V26, V210, V211	1					2	3
6080	V220, V221						2	2
6J6	V23, V24	2						2
	TOTALS	28	5	5	5	5	24	72
1N23C	CR401, CR501		1	1				2
1N2[illegible] or 1979	CR601, CR701				1	1		2
1N82A	CR801	1						1
1N69	CR1, CR2	2						2
1N198		1						1
	TOTALS	4	1	1	1	1		8

TABLE V. FUSE AND INDICATOR LAMP COMPLEMENT

Major Components

FUSES

Type	Ref. Symbol	Monitor Unit	Band 1 Rf Tuning Unit	Band 2 Rf Tuning Unit	Band 3 Rf Tuning Unit	Band 4 Rf Tuning Unit	Power Unit	Qty per Equip.
F03G10R0A, 10 amp (operating)	F201, F202						2	2
F03G10R0A, 10 amp (spares)							2	2
	TOTAL						4	4
INDICATOR LAMPS								
GE 47	DS201, DS202, DS403, DS404, DS503, DS504, DS603, DS604, DS703, DS704		2	2	2	2	2	10
GE NE51	DS405, DS406, DS407 DS505, DS506, DS507, DS605, DS606, DS607, DS705, DS706, DS707		3	3	3	3		12
AN3140-328	DS401, DS402, DS501, DS502, DS601, DS602, DS701, DS702		2	2	2	2		8

SECTION B

INSTALLATION AND ADJUSTMENT

7. GENERAL.

This section of the handbook contains instructions for installing and adjusting the [illegible]. Because of the different types of measurements possible with the equipment, and due to the wide frequency coverage possible, the instructions contained in this section are generalized. Refer to section C for specific operating instructions, after the equipment has been properly set up as outlined below.

8. UNPACKING THE EQUIPMENT.

a. The equipment is shipped complete, and is ready for use after unpacking. The equipment is portable, and may be used for both laboratory and field tests.

b. After unpacking, place the Monitor Unit on the work bench, with the front panel controls available for ease of operation. The desired frequency coverage determines the choice of Tuning Unit to be employed in a particular test. Observe the frequency range of the Tuning Unit shown in the frequency dial window. Table II, in section A of this handbook, lists the frequency of each Tuning Unit supplied with the equipment.

c. Place the Power Unit on the work bench, within a distance of eight feet from the Monitor Unit.

d. Unpack both the antenna parking, cables and two cables, reflector, and tripod mounting plate. These crates contain the following components:

(1) The omnidirectional antenna;

(2) The two directive antennas (one for Band 1, [illegible] for Band 2);

(3) The two feed horns (one for Band 3, and one for Band 4);

(4) The antenna reflector (for use with either the Band 3 or Band 4 feed horn);

(5) The tripod;

(6) The accessory cables

e. Set up the tripod on its legs, with the legs extended to the desired height, within the limits of 36-1/2 to 60 inches. If the equipment is to be used within the laboratory, attach the rubber tips to the leg ends; if measurements are to be taken outdoors, use the metal tips at the leg ends.

f. Attach the desired antenna to the top of the tripod, by means of the bracket attachment on the antenna.

9. SYSTEM INTERCONNECTIONS. (See figure 1.)

To connect the several components of the system together, refer to figure 1 and proceed in accordance with the following steps:

a. Use power cable W905 (10 ft.) to apply nominal 115-volt, 50 to 60 cps, power to the three-terminal POWER INPUT connector J203, located at the rear of the Power Unit.

b. Use interconnecting cable W903 (8 ft.) to connect receptacle J201, at the rear of the Power Unit, to receptacle J18 at the rear of the Monitor Unit.

c. Remove the desired Tuning Unit from its dust cover by unfastening the four cam locks located in each of the four corners on the front panel.

d. Secure the Tuning Unit into the Monitor Unit chassis with the four cam locks.

CAUTION

DO NOT INSERT OR REMOVE THE TUNING UNIT FROM THE MONITOR UNIT WHEN THE FREQUENCY DIAL IS POSITIONED NEAR THE LOW END OF THE BAND.

e. Open the 6 inch by 4 inch door located on the left-side of the Monitor Unit dust cover and connect the following receptacles: (refer to figure 37.)

Band 1 Reference Symbols

1) J111 to P118
2) J127 to P137
3) J138 to P138
4) J139 to P139

f. Use the 6-foot rf cable, W902, to connect the R.F. IN receptacle on the Monitor Unit to the connector on the bracket of the antenna selected for use with a particular Tuning Unit.

g. Use cable W122 (4-3/4 in.) to connect the 140 MC OUT jack to the 140 MC IN jack, both of which are located on the front panel of the selected Tuning Unit.

h. Use cable W121 (8") to connect the CAL. IN jack on the Monitor Unit to the SIG. GEN. OUT jack located on the front panel of the selected Tuning Unit

NOTE

When Band 3 or Band 4 feed horn is in use, connect the rf cable between the R.F. IN receptacle on the Monitor Unit and the bulkhead connector mounted on the bracket of the antenna reflector. Be sure to check that the feed horn is connected, by means of an additional short length of rf cable, to the other termination of the bulkhead connector.

10. ADJUSTMENTS.

When the system has been installed in accordance with the instructions listed in paragraph 9, above, perform an operating check of the equipment, as directed in section C of this handbook. Should circuit adjustments be required, refer to tables VI, VII, and VIII, which list the designation and function of the operating controls located on the front panels of the Tuning, Monitor, and Power Units.

11. DIMENSIONAL DATA.

Dimensional data for the various major components of the FIM are given in figures 6 through 11. The data included in these illustrations can be used for estimating space requirements for operation, and in planning storage or transportation facilities for the equipment.

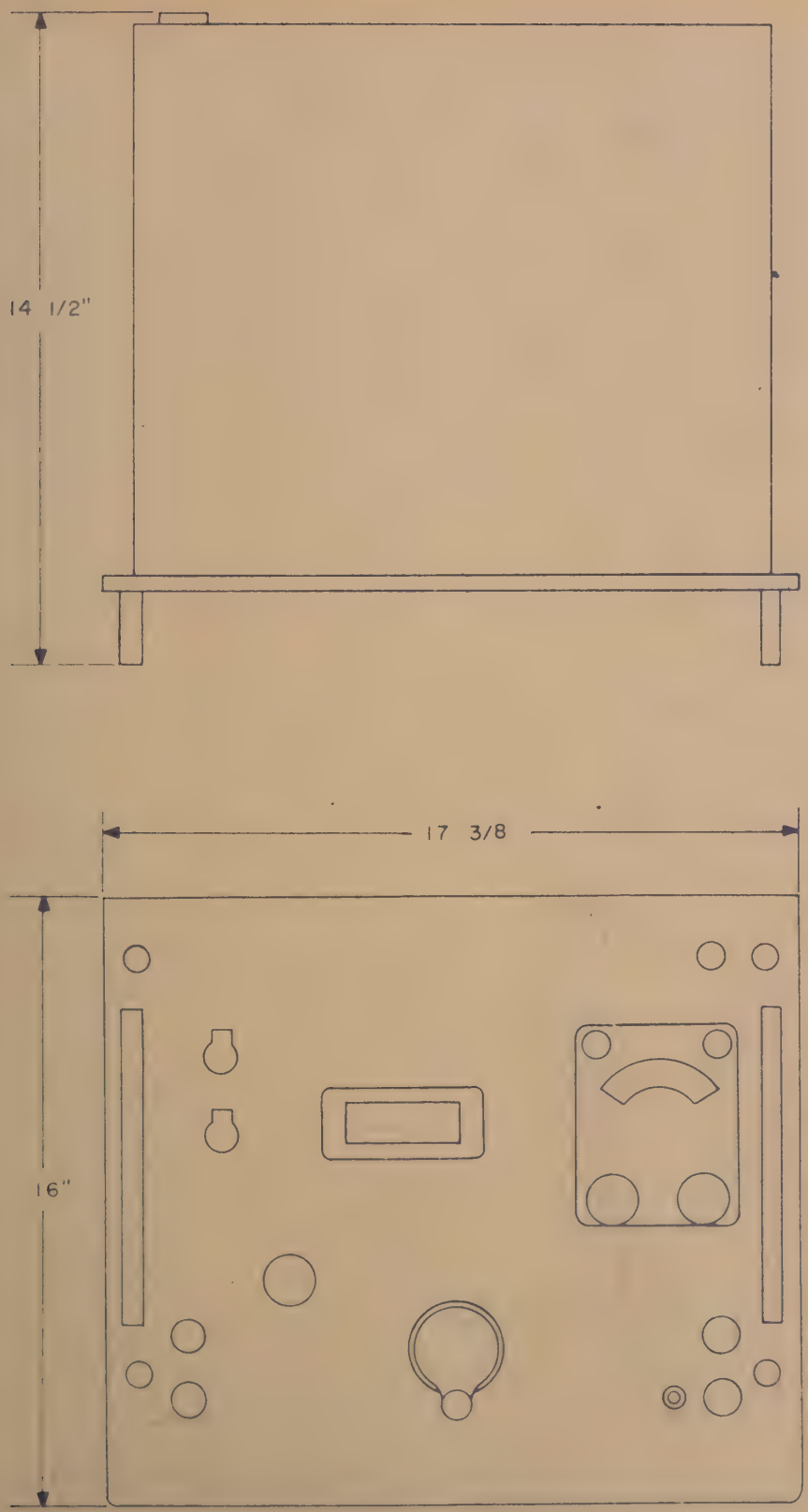


FIGURE 7. TYPICAL TUNING UNIT, OUTLINE DRAWING

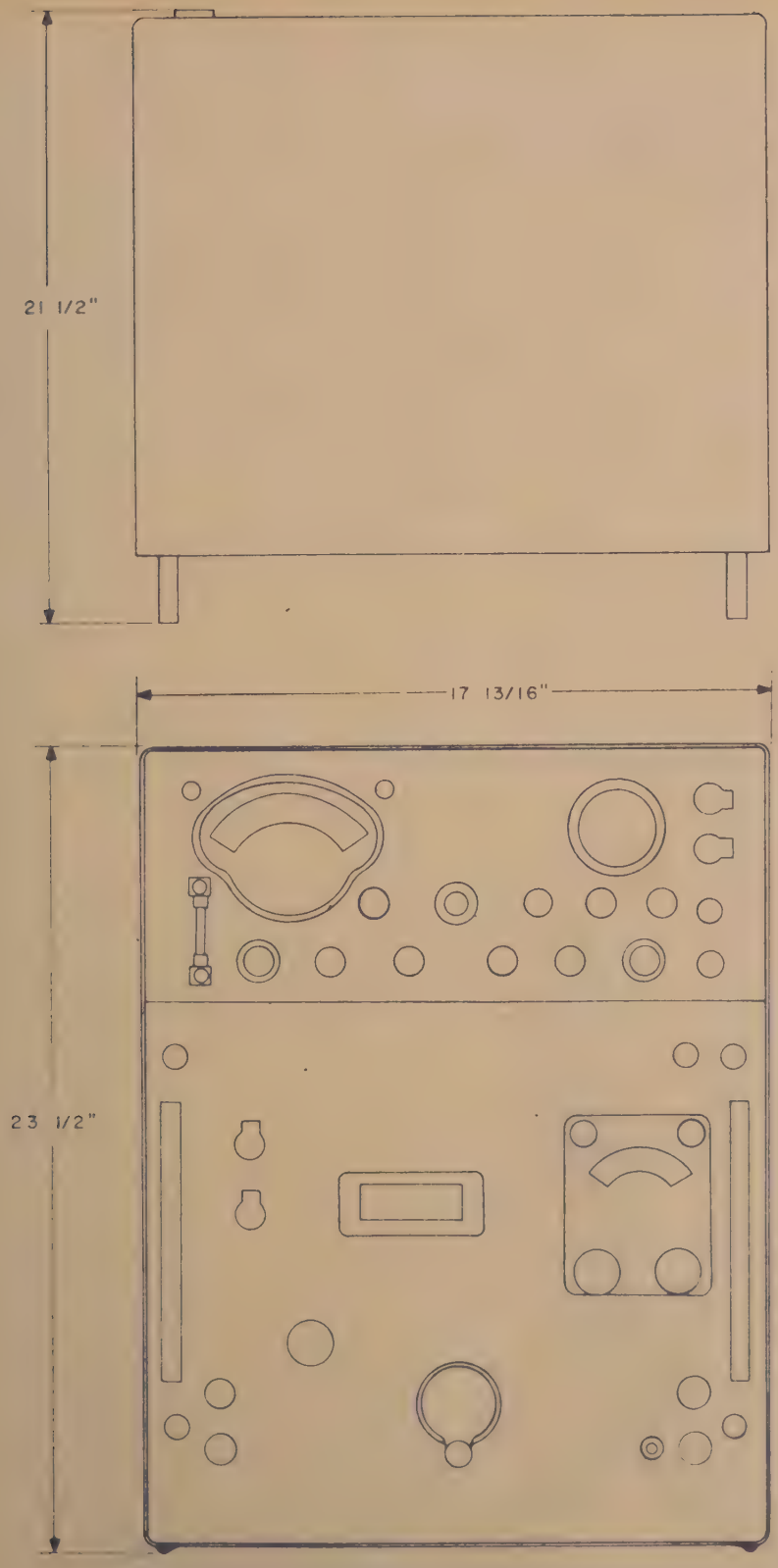


FIGURE 6. MICROWAVE FIELD INTENSITY METER, MODEL FIM, OUTLINE DRAWING

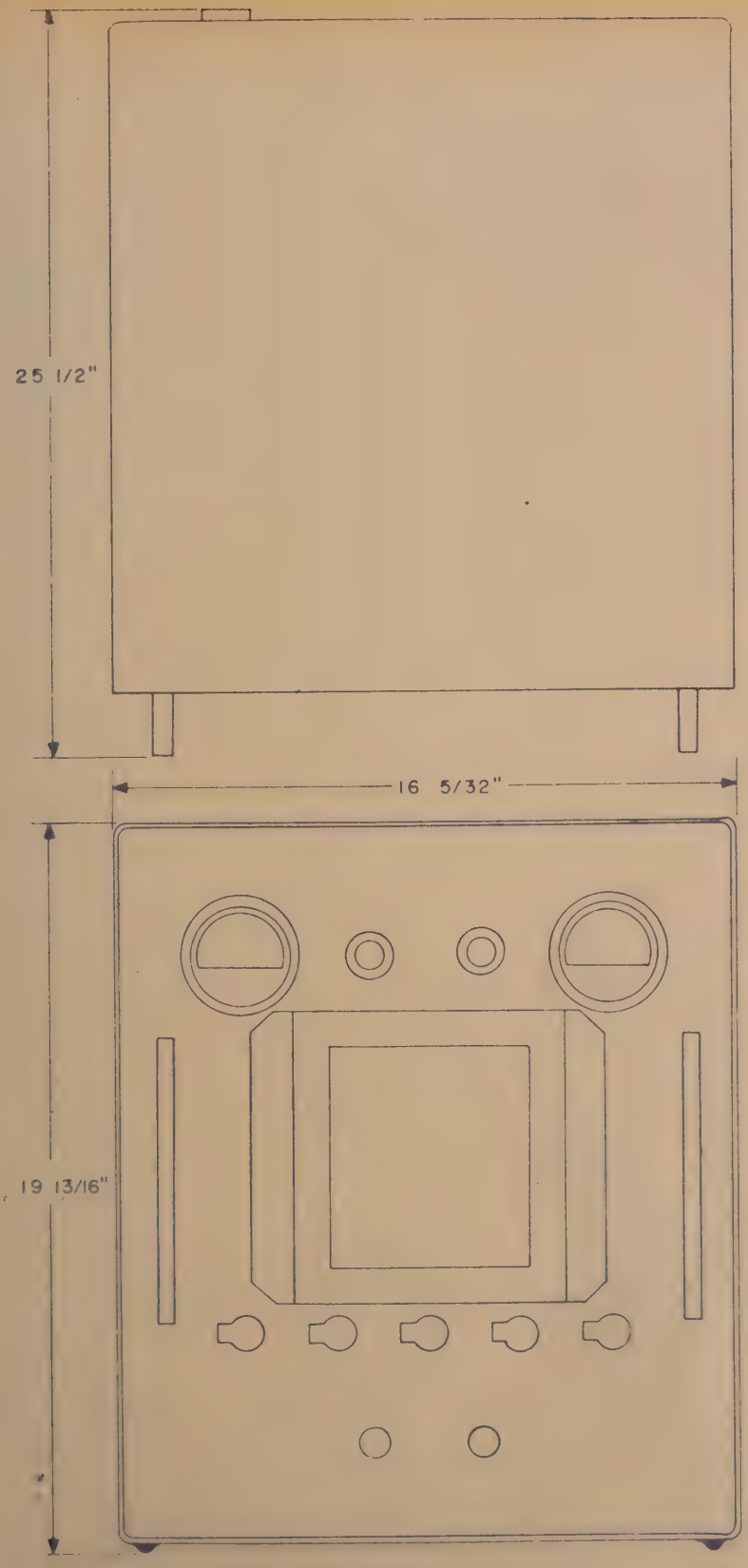


FIGURE 8. POWER UNIT, MODEL FIM-P, OUTLINE DRAWING

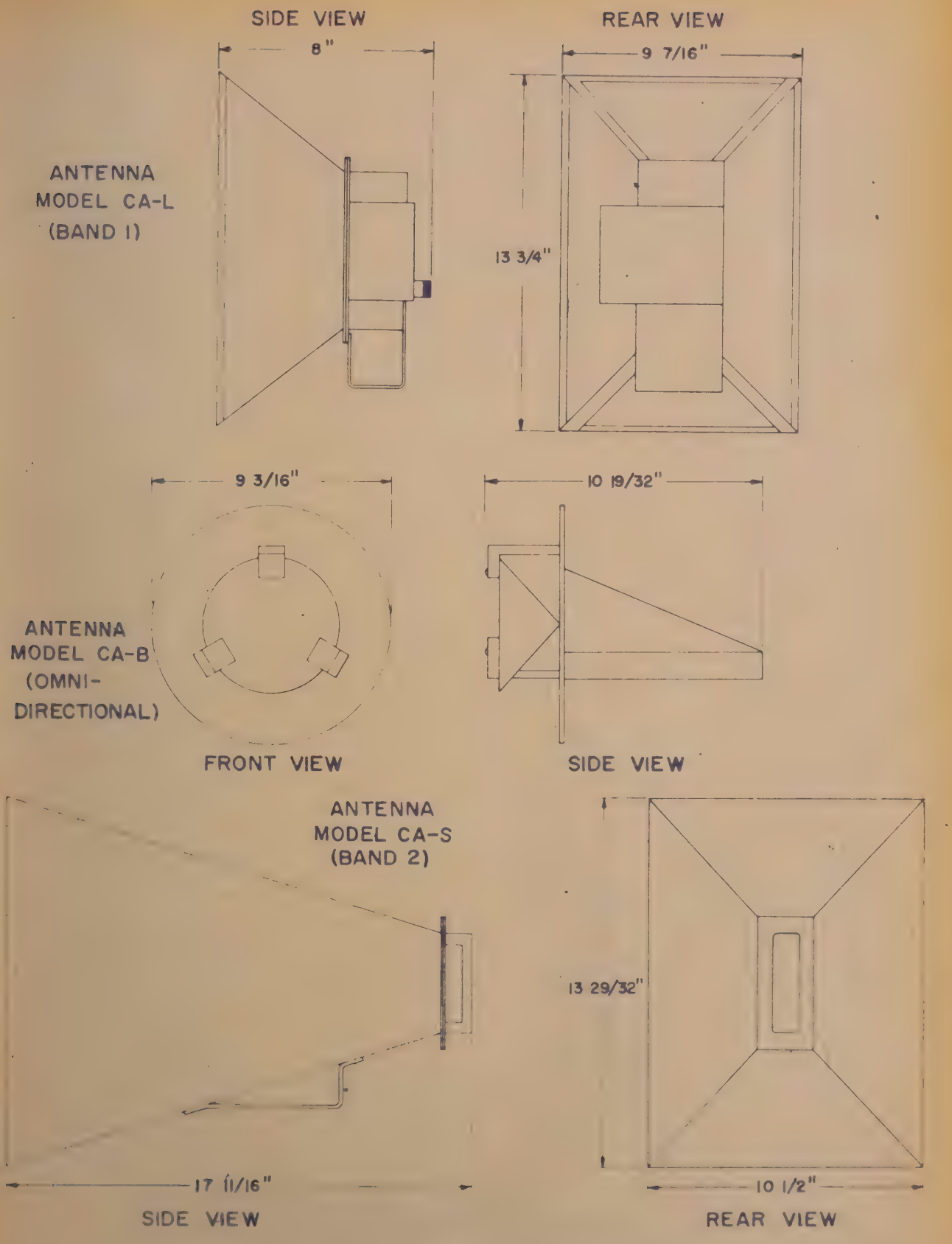


FIGURE 9. OMNIDIRECTIONAL ANTENNA, WITH BAND 1 AND BAND 2 DIRECTIVE ANTENNAS, OUTLINE DRAWING.

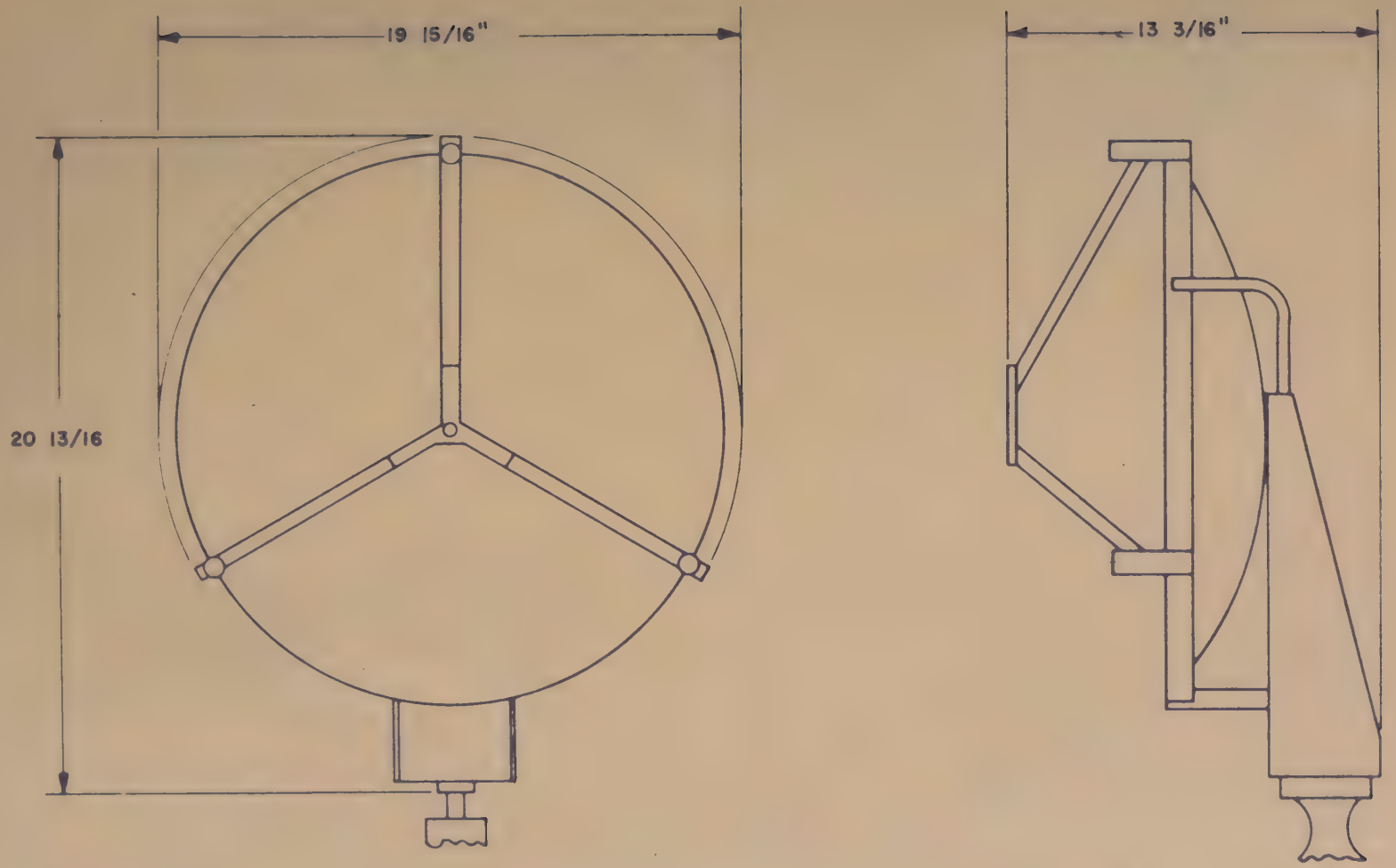


FIGURE 10. ANTENNA REFLECTOR MODEL CA-R OUTLINE DRAWING.

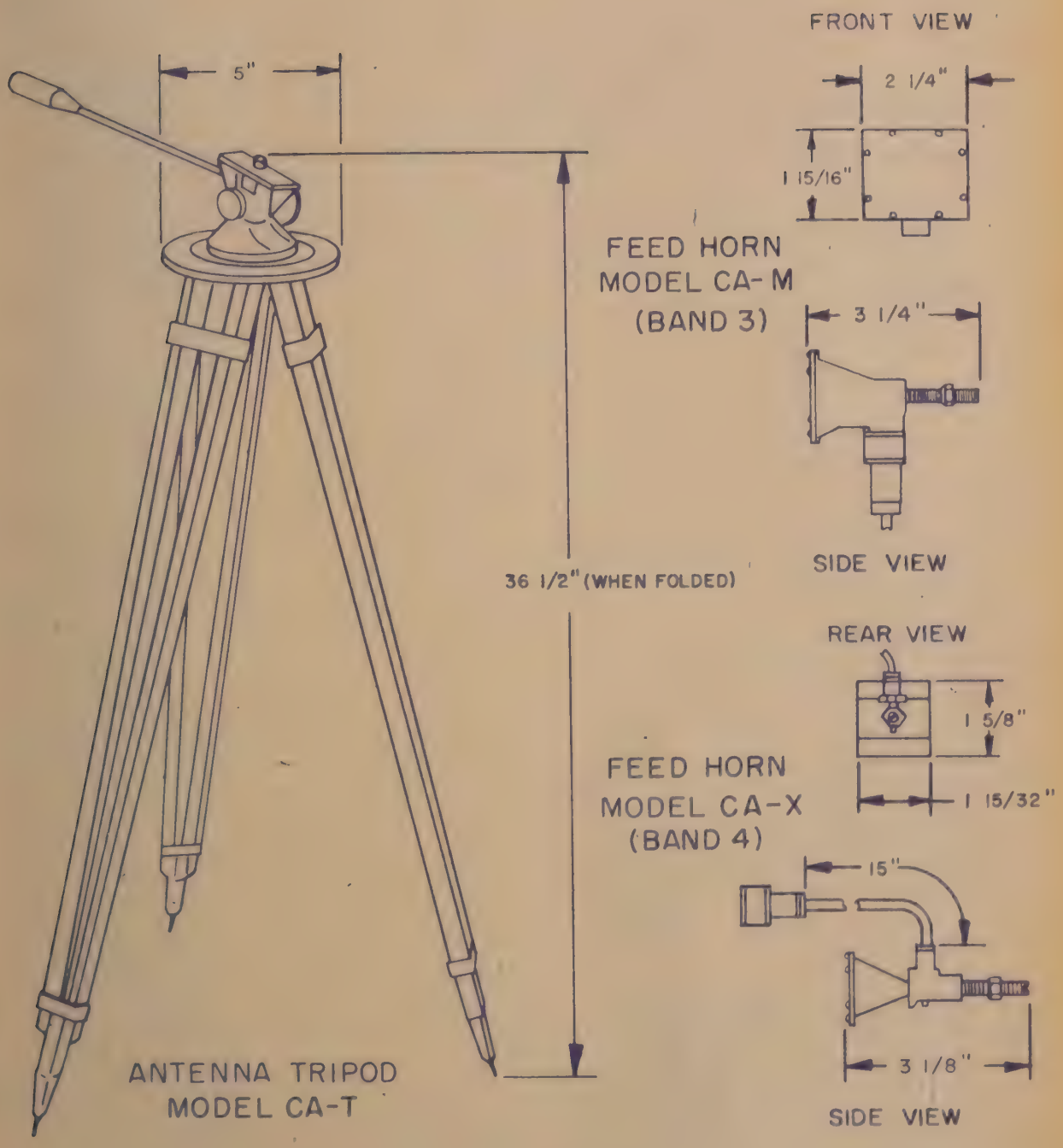


FIGURE 11. TRIPOD, WITH BAND 3 AND BAND 4 DIRECTIVE HORNS, OUTLINE DRAWINGS

SECTION C
OPERATION

12. EQUIPMENT CONTROLS AND INDICATORS.

The operating controls and indicators for the FIM are located on the front panels of the three unitized sections of the equipment. The function of each control is briefly described by an adjacent panel marking. Refer to table VI for a listing, index number reference, and purpose of each control on the Tuning Unit; to table VII for each control on the Monitor Unit; and to table VIII for similar data on the Power Unit.

TABLE VI. TUNING UNIT CONTROLS

Designation	Figure and Index No.	Function
SIG. GEN. OUT jack	12-1	This coaxial jack is provided so that the internal signal generator output can be used externally.
TUNING control and dial	12-2	Rotation of this control tunes both the klystron local oscillator and the klystron signal calibrator to the desired frequency, as indicated by the calibration mark under the hairline in the dial window. NOTE The setting of the "function selector", in the lower-right section of the front panel, determines whether the incoming rf signal or the calibrating generator signal is applied to the input of the receiver. (In ZERO SET position, the receiver input is disconnected from both the incoming rf signal and the signal calibrator.)
SIGNAL CALIBRATOR FINE TUNING control	12-3	Rotation of this control permits fine control over the voltage applied to the repeller electrode of the klystron signal calibrator.

TABLE VI. TUNING UNIT CONTROLS (Cont' d)

Designation	Figure and Index No.	Function
POWER switch	12-4	Controls input power to equipment as follows: a. In STANDBY position, applies input power to space heaters and STANDBY pilot lamp. b. In POWER ON position, applies power to Power Unit and POWER ON pilot lamp.
SIGNAL CALIBRATOR OUTPUT ATTENUATOR control and dial	12-5	Rotation of this control changes the position of the pickup loop in the output of the klystron signal calibrator cavity. By this means, the output level of the signal calibrator can be accurately set.
SIGNAL CALIBRATOR COARSE TUNING control	12-6	Rotation of this control permits fine control over the position of the tuning plunger in the cavity of the klystron signal calibrator.
SIGNAL CALIBRATOR POWER SET control	12-7	Rotation of this control provides the calibrating power reference level of the signal calibrator, by balancing the power monitor bridge. Indications are observed on the Monitor Unit POWER MONITOR meter with meter selector in POWER MON. position.
AFC adjustment	12-8	A front panel screwdriver adjustment for balancing the afc circuit in the absence of signal. One such adjustment is provided in Bands 2 and 3, and two such adjustments are provided in Bands 1 and 4.

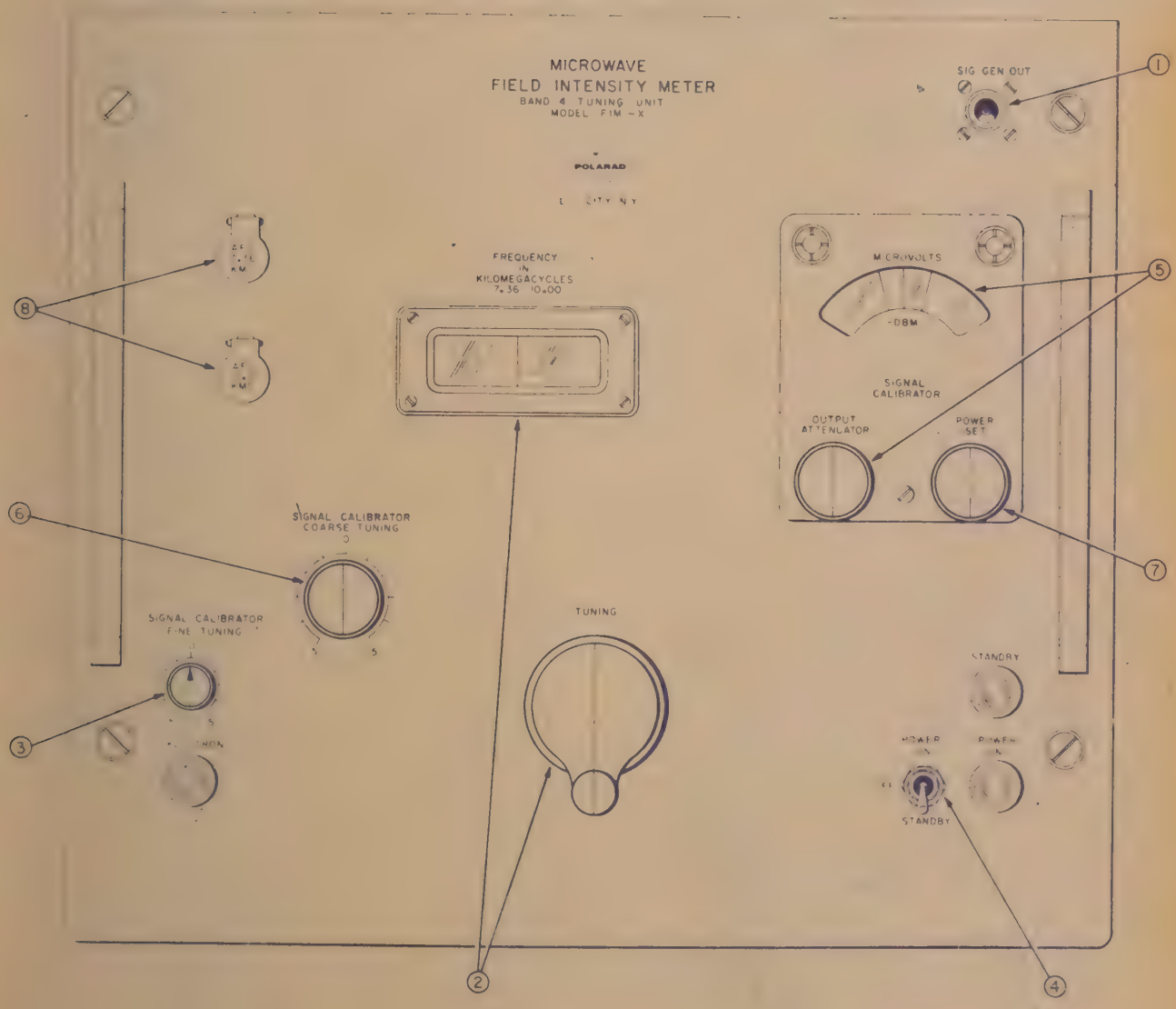


FIGURE 12. TYPICAL TUNING UNIT, OPERATING CONTROLS

TABLE VII. MONITOR UNIT CONTROLS

Designation	Figure and Index No.	Function
Output Meter Function Selector switch	13-1	The setting of this rotary 4-position switch determines the type of measurement desired, as follows: a. In its ZERO SET position, signal input is removed from the metering circuit, and the OUTPUT METER may be set to zero indication. b. In its AVERAGE position, the proper weighting circuit is connected to the metering circuit for average measurement of signals. c. In its QUASI-PEAK position, the proper weighting circuit is connected to the metering circuit for quasi-peak measurement of signals. d. In its PEAK position, the proper weighting circuit and the SLIDEBACK control are connected to the metering circuit for peak measurement of signals.
OUTPUT METER	13-2	Used as the indicating device for measurement of average, quasi-peak, and peak value of signals.
Output Meter ZERO SET control	13-3	Rotation of this control permits zero-setting the OUTPUT METER, with its Output Meter Function Selector switch also in ZERO SET position.
METER SELECTOR switch	13-4	This 3-position rotary switch selects the type of indication desired on the POWER MONITOR meter, as follows: a. In its AFC BAL. position, the meter indicates the unbalance in the afc circuit. b. In its XTAL CUR. position, the meter indicates the d-c current flow in the first crystal mixer circuit. c. In its POWER MON. position, the meter indicates the current flow in the power monitor bridge circuit. The meter pointer can be set by variation of the power monitor ZERO SET and SIGNAL CALIBRATOR POWER SET controls.
POWER MONITOR meter	13-5	Used as the indicating device for measurement of afc balance current, first crystal mixer current, and rf power monitor bridge current.

TABLE VII. MONITOR UNIT CONTROLS (Cont'd)

Designation	Figure and Index No.	Function
Power Monitor ZERO SET control	13-6	Rotation of this control permits zero-setting of the POWER MONITOR meter, with its METER SELECTOR switch in POWER MON position (Output Meter Function Selector at ZERO SET).
I. F. GAIN control	13-7	Rotation of this potentiometer controls the overall gain of the i-f amplifier chassis, by varying the bias voltage applied to the second and third stages of the 140-mc triplet amplifier.
SLIDEBACK control	13-8	This control is used in measuring the peak value of signals, and is varied clockwise until the signal disappears in the headphones which are connected to the AUDIO OUT jack during this measurement. This control applies a bucking voltage to the detected signal and thus causes the OUTPUT METER to indicate the peak value of the signal when the bucking voltage is equal to the peak value of the detected signal.
AUDIO GAIN control	13-9	Rotation of this potentiometer determines the amplitude of detected signal applied to the audio amplifier circuit.
AURAL TUNING AID control	13-10	This control is used when audio monitoring of unmodulated signals is desired. Clockwise rotation of this control beyond its off position energizes the 1,000-cps audio oscillator; further clockwise rotation increases the amplitude of the modulation voltage, which is injected into the doubler stage of the crystal-controlled local oscillator. This artificial modulation of the incoming signal facilitates detection.
VIDEO OUT jack	13-11	This coaxial jack is provided for connection of the detected output signal to an oscilloscope, when external video presentation of the modulation envelope is desired.
RECORDER OUT jack	13-12	This telephone jack is provided for connection of the output signal to a one-milliampere movement external recorder, such as the Angus-Esterline type, when desired. The recorder gives the same indication as the front panel OUTPUT METER.
AUDIO OUT jack	13-13	This telephone jack is provided for connection of the detected signal to a pair of headphones, when aural monitoring of the signal is desired.

TABLE VII. MONITOR UNIT CONTROLS (Cont'd)

Designation	Figure and Index No.	Function
140 MC OUT jack	13-14	Provides means of inserting an external i-f attenuator.
140 MC IN jack	13-15	Provides means of inserting an external i-f attenuator.
AFC switch	13-16	This switch, in its IN position, provides automatic frequency control. The afc amplifier, in the Tuning Unit, controls the reflector voltage applied to the local oscillator klystron tube. By the "electronic tuning" of the klystron, the afc circuit compensates for any long period frequency drift in the incoming signal.
INPUT ATTENUATOR switch	13-17	This 5-position rotary switch provides rf and i-f attenuation of the signal (from either the applied rf or the signal calibrator) as follows: Attenuation (in db) Position — RF — IF — TOTAL 0 db x1 — 0 — 0 — 0 20 db x10 — 0 — 20 — 20 40 db x100 — 20 — 20 — 40 60 db x1000 — 40 — 20 — 60 80 db x10,000 — 60 — 20 — 80
R. F. IN jack	13-18	Accepts the incoming rf signal via the 6-ft. rf cable.
CAL IN jack	13-19	Accepts the signal generator output signal from the SIG. GEN. OUT jack, figure 12-1, via the 8-inch interconnecting cable.
"Function Selector" switch	13-20	This 3-position rotary switch is set to correspond to the function for which the instrument will be used. a. In its ZERO SET position, both the incoming rf signal and the output of the klystron signal calibrator are disconnected from the input to the receiver, permitting zero-setting of the OUTPUT METER located on the Monitor Unit front panel. In addition, the signal calibrator is turned off by biasing its grid beyond cutoff. b. In its CAL. -SIG. GEN position, an electrically-operated rf transfer switch is energized to that position which applies only the output of the signal calibrator to the receiver input. The signal calibrator is energized by biasing its grid to the value which permits normal operation of the signal calibrator.

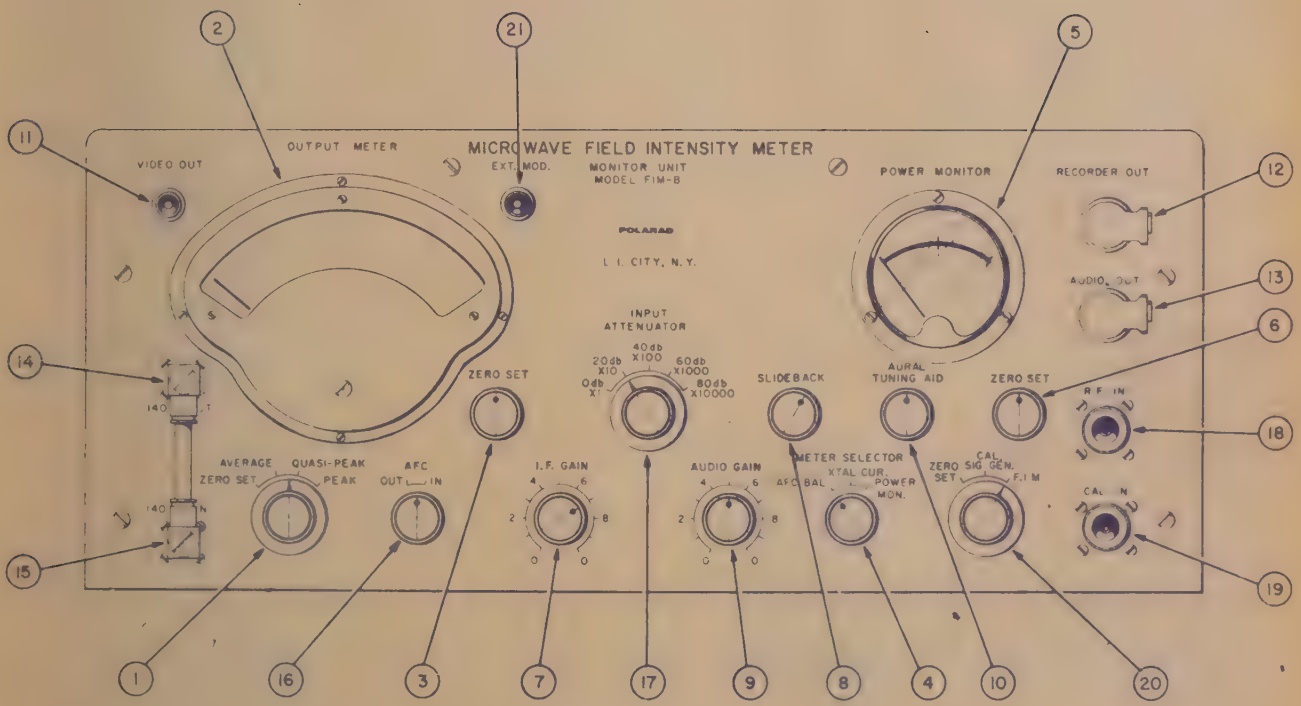


FIGURE 13. MONITOR UNIT, OPERATING CONTROLS

TABLE VII. MONITOR UNIT CONTROLS (Cont'd)

Designation	Figure and Index No.	Function
		c. In its F.I.M. position, the electrically operated rf transfer switch is energized to that position which applies only the signal connected to the R.F. IN jack to the receiver input. The signal calibrator is again de-energized by biasing its grid beyond cutoff.
EXT. MOD. jack	13-21	Accepts a signal from an external modulation source, if external modulation is desired.

TABLE VIII. POWER UNIT CONTROLS

Designation	Figure and Index No.	Function
KLYSTRON CATHODE CURRENT switch	14-1	This 2-position rotary switch permits selection of either the klystron local oscillator or klystron signal calibrator cathode current for visual presentation on the left-hand panel meter.
VOLTMETER switch	14-2	This 4-position rotary switch permits selection of any of the following output voltages from the Power Unit for monitoring on the right-hand panel meter: a. Bias potential (-108 volts); b. Low voltage (+130 volts); c. Repeller supply voltage; d. Beam voltage.
BEAM VOLTAGE ADJ. controls	14-3	a. BANDS 1 & 2 screwdriver control permits adjustment of the beam voltage when either the Band 1 or Band 2 Tuning Unit is in operation. This voltage can be monitored by having the VOLTMETER switch in the BEAM position. b. BAND 3 control permits screwdriver adjustment of the beam voltage when the Band 3 Tuning Unit is in operation. This voltage can be monitored by having the VOLTMETER switch in the BEAM position. c. BAND 4 control permits screwdriver adjustment of the beam voltage when the Band 4 Tuning Unit is in operation. This voltage can be monitored by having the VOLTMETER switch in the BEAM position.
REPELLER VOLTAGE ADJ. control	14-4	This potentiometer permits screwdriver adjustment of the repeller output potential from the Power Unit. This voltage can be monitored by having the VOLTMETER switch in the REPELLER position.
LOW VOLTAGE ADJ. control	14-5	This potentiometer permits screwdriver adjustment of the low-voltage output from the Power Unit. This voltage can be monitored by having the VOLTMETER switch in the LOW VOLTAGE position.

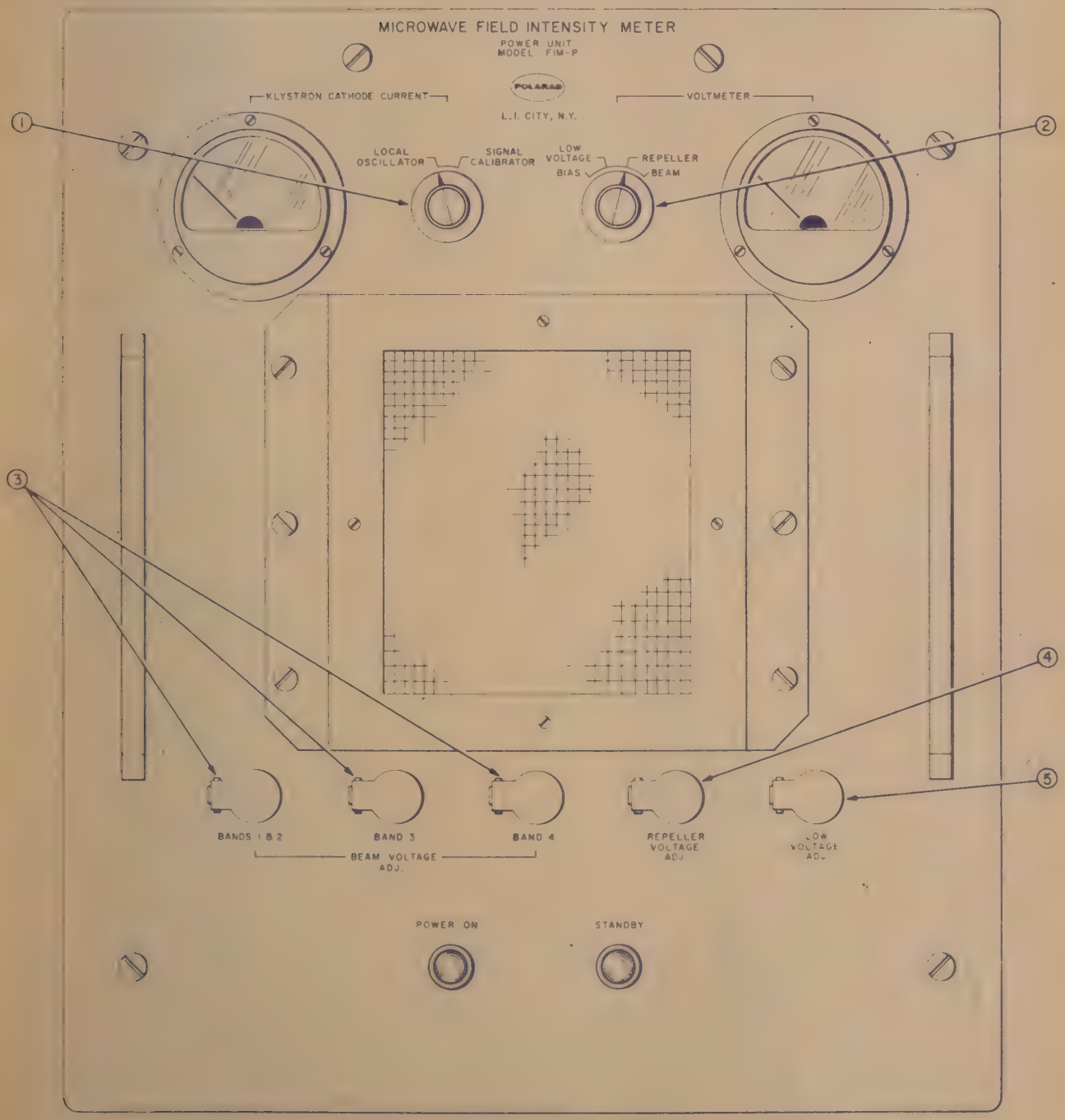


FIGURE 14. POWER UNIT, OPERATING CONTROLS

13. INITIAL SETTING OF CONTROLS.

Before applying operating power to the instrument, place the front panel operating controls to the positions indicated in table IX, and refer to figures 12, 13, and 14.

TABLE IX. INITIAL SETTING OF CONTROLS AND INTERCONNECTIONS

Control	Figure and Index No.	Position
SIG. GEN. OUT jack	12-1	Connected via interconnecting cable to CAL. IN. jack on Monitor Unit
TUNING control	12-2	Any point on dial
SIGNAL CALIBRATOR FINE TUNING control	12-3	Mid-position
POWER switch	12-4	OFF
SIGNAL CALIBRATOR OUTPUT ATTENUATOR control	12-5	COUNTERCLOCKWISE
SIGNAL CALIBRATOR COARSE TUNING control	12-6	Mid-position
SIGNAL CALIBRATOR POWER SET control	12-7	COUNTERCLOCKWISE
Output Meter Function Selector switch	13-1	AVERAGE
Output Meter ZERO SET control	13-3	Mid-position
METER SELECTOR switch	13-4	XTAL CUR.
Power Monitor ZERO SET control	13-6	[illegible]

TABLE IX. INITIAL SETTING OF CONTROLS AND INTERCONNECTIONS (Cont'd)

Control	Figure and Index No.	Position
I. F. GAIN control	13-7	COUNTERCLOCKWISE
SLIDEBACK control	13-8	Fully counterclockwise
AUDIO GAIN control	13-9	Mid-position
AURAL TUNING AID control	13-10	Off
RECORDER OUT jack	13-12	Connected to external 1-ma. recorder, if desired
AUDIO OUT jack	13-13	Connected to headset, if aural monitoring of signal is desired
140 MC OUT jack	13-14	Connected via interconnecting cable to 140 MC IN jack
140 MC IN jack	13-15	Connected via interconnecting cable to 140 MC OUT jack
AFC switch	13-16	OUT
INPUT ATTENUATOR switch	13-17	0 db X1
R. F. IN jack	13-18	Connected to signal source
CAL. IN jack	13-19	Connected via interconnecting cable to SIG. GEN. OUT jack on Tuning Unit
"Function Selector" switch	13-20	F. I. M.
EXT. MOD. jack	13-21	Connected to an external modulation source if desired
KLYSTRON CATHODE CURRENT meter selector	14-1	LOCAL OSCILLATOR

14. OPERATING PROCEDURE. (See figures 12, 13, and 14.)

Before applying power to the equipment, perform the following steps:

Step 1. Connect the interconnecting cable from the Monitor Unit to the multi-pin connector at the rear of the Power Unit.

Step 2. Connect the rf cable from the source of the signal under measurement (the antenna or other signal source) to the R. F. IN jack (18, fig. 13). See table IX for initial control settings.)

Step 3. Connect the power cable from the Power Unit connector (at the rear of the unit) to a power source capable of supplying 115 volts ac, 50 to 450 cps power. Place the POWER switch (4, fig. 12) in STANDBY position. Observe that the STANDBY pilot lamps on both the Power and Tuning Unit front panels become illuminated.

NOTE

In ambient temperatures below approximately 0°C (32°F), leave the equipment in standby condition for at least 30 minutes. During this interval, the space heaters within the equipment will dry out condensed moisture and raise the temperature of the internal components.

Step 4. Place the POWER switch (4, fig. 12) to the POWER ON position. Observe the following indications:

a. The STANDBY pilot lamps (white) on the Power and Tuning Unit panels become extinguished.

b. The POWER ON (amber) pilot lamp becomes illuminated.

c. The blower motor in the Power Unit rotates.

d. After a delay of approximately 30 seconds, the pointer of the OUTPUT

METER (2, fig. 13) deflects to an on-scale indication from its rest position.

e. After a delay of approximately 30 seconds, the pointer of the Power Unit VOLTMETER deflects to mid-scale.

Step 5. Rotate the VOLTMETER selector (2, fig. 14) to the LOW VOLTAGE position. Observe the meter pointer for a mid-scale indication. Vary the LOW VOLTAGE ADJ. control (5, fig. 14), if necessary, to obtain a mid-scale pointer deflection.

Step 6. Rotate the VOLTMETER selector to the REPELLER position. Observe the meter pointer for a mid-scale indication. Vary the REPELLER VOLTAGE ADJ. control (4, fig. 14), if necessary, to obtain a mid-scale pointer indication.

Step 7. After a delay of approximately 60 seconds from the time that the POWER switch was thrown to the POWER ON position, observe the following indications:

a. The pointer of the OUTPUT METER (2, fig. 13) deflects further to the right.

b. The pointer of the POWER MONITOR meter (5, fig. 13) deflects to an on-scale value.

c. The KLYSTRON (red) pilot lamp on the Tuning Unit panel becomes illuminated.

d The KLYSTRON CATHODE CURRENT meter pointer, on the Power Unit, deflects to an indication between approximately 20 and 30 ma.

Step 8. Rotate the VOLTMETER selector to the BEAM position. Observe the meter pointer for a mid-scale indication. Vary the applicable BEAM

VOLTAGE ADJ. control (depending on the Tuning Unit in use) to obtain a mid-scale pointer deflection.

NOTE

These voltages are acceptable when the meter indicates anywhere on the red portion of the VOLTMETER scale.

Step 9. Rotate Output Meter Function Selector switch (1, fig. 13) to ZERO SET, and adjust Output Meter ZERO SET control (3, fig. 13) to obtain a zero-set pointer deflection. (Pointer deflects to extreme left-hand calibration mark on meter scale.)

Step 10. Return Output Meter Function Selector switch (1, fig. 13) to AVERAGE position.

Step 11. Rotate the TUNING control (2, fig. 12) to search for the presence of an rf signal. A signal is being picked up by the receiver if the following indication(s) are observed:

NOTE

The AFC switch (16, fig. 13) should ordinarily be in its OUT position when tuning.

a The pointer of the OUTPUT METER (2, fig. 13) deflects further to the right. In the event that the pointer deflects to an off-scale indication, rotate the INPUT ATTENUATOR switch (17, fig 13) clockwise to the first setting which permits an on-scale indication to be obtained.

b. With a headset plugged into the AUDIO OUT jack (13, fig. 13) and the AUDIO GAIN control advanced from its extreme counterclockwise position, a tone will be heard if the signal being received is a modulated signal.

c. If an unmodulated signal is being received, rotate the AURAL TUNING AID control (10, fig. 13) clockwise beyond its off position to produce a 1000-cps beat signal. In the presence of an incoming signal, this 1000-cps note is much louder than in the no-signal condition.

d. Connect the VIDEO OUT JACK (11, fig. 13) to the vertical input of an oscilloscope. The signals modulation, if any, will appear on the oscilloscope screen.

NOTE

The procedures outlined in paragraphs c and d, above, are required when the duty cycle of a pulsed signal is too low to produce a measurable deflection on the OUTPUT METER, and the Output Meter Function Selector switch (1, fig. 13) is at AVERAGE position. These procedures can, however, be used at any time that a visual or aural indication is desired.

Step 12. The following steps should be performed when using AFC.

a. Rotate Function Selector switch to the ZERO SET position.

b. Set the AFC switch to the OUT position.

c. Rotate the METER SELECTOR switch to the AFC BAL. position.

d. Note the reading on the POWER MONITOR meter. It should indicate CAL.

e. Set the AFC switch to the IN position.

f. When using band 2 or 3, turn the AFC adjustment on the tuning head for an indication on the POWER MONITOR meter equal to that of step d.

g. When using band 1 or 4, the Low Frequency AFC Adjustment is used below the switch point and the High

Frequency AFC Adjustment is use above the switch point (approximately 1.3 KMC on band 1 and 9.3 KMC on band 4). Rotate the proper AFC adjustment to give the same indication on the POWER MONITOR meter as obtained in step d.

h. Rotate the METER SELECTOR switch to the XTAL CUR. position.

i. Rotate the Function Selector switch to the F.I.M. position and peak the incoming signal by rocking the TUNING control.

Step 13. To measure the frequency of the incoming signal, rock the TUNING control (2, fig. 12) in the vicinity of the signal to obtain the maximum pointer deflection on the OUTPUT METER (2, dig. 13) and/or the maximum audio or video response, as applicable. Read the setting of the FREQUENCY IN KILOMEGACYCLES dial under the hairline on the Tuning Unit window. Be sure that the AFC switch is rotated to its OUT position, and the coarse and fine tuning controls are centered, since frequency measuring accuracy will be affected by these controls.

Step 14. To measure the average field intensity of the incoming signal, two methods of procedure are available. Both methods apply when the Output Meter Function Selector switch (1, fig. 13) is rotated to the AVERAGE position. One method is the full-scale calibration technique (described below in paragraph 15); the other is the substitution method (described in paragraph 16). To measure the quasi-peak or peak value of the signal, refer to paragraph 18 or 19, respectively.

15. FULL-SCALE CALIBRATION METHOD FOR MEASURING AVERAGE POWER LEVEL. (See figures 12 and 13.)

a. The following operating procedure is based on the assumption that the incoming rf signal power is less than zero dbm (approximately 200 millivolts). Observe that the meter pointer on the OUTPUT METER (2, fig. 13) deflects to an on-scale indication with the INPUT ATTENUATOR switch (17, fig. 13) in its 0 db, 20 db, or 40 db position.

NOTE

If the INPUT ATTENUATOR switch (17, fig. 13) must be set to the 60 db x1000 or 80 db x10,000 position in order to obtain an on-scale OUTPUT METER indication, refer to the operating instructions outlined in paragraph 17.

Step 1. Rotate the "function selector" (20, fig. 13) to the ZERO SET position.

Step 2. Rotate METER SELECTOR switch (4, fig. 13) to the POWER MON. position.

Step 3. Vary the setting of Power Monitor ZERO SET control (6, fig. 13) to obtain a zero pointer deflection on the POWER MONITOR meter (5, fig. 13).

Step 4. After zero-setting the POWER MONITOR meter, rotate the "function selector" (20, fig. 13) to the CAL. -SIG. GEN. position.

Step 5. Vary the setting of SIGNAL CALIBRATOR POWER SET control (7, fig. 12) to obtain a pointer deflection at the CAL mark on the POWER MONITOR meter (5, fig. 13).

Step 6. Vary the SIGNAL CALIBRATOR OUTPUT ATTENUATOR control (5, fig. 12) to obtain that reading on the attenuator dial which corresponds to the full-scale indication on the OUTPUT METER (2, fig. 13), multiplied by the panel marking of the INPUT ATTENUATOR switch (17, fig. 13) settings. For example: If the INPUT ATTENUATOR switch is set to 0 db x1, vary the SIGNAL CALIBRATOR OUTPUT ATTENUATOR control (5, fig. 12) to obtain an attenuator dial indication of 1K (X1) on the microvolts calibration scale.

As a second example: If the INPUT ATTENUATOR switch is set to 40 db X100, vary the SIGNAL CALIBRATOR OUTPUT ATTENUATOR control (5, fig. 12) to obtain an attenuator dial indication of 1,000 microvolts X100, or a dial indication of 100K on the microvolts calibration scale.

Step 7. In all cases, refer to the calibration curves supplied with the equipment to obtain the corrected value of the signal calibrator output level. This correction is supplied for the particular frequency under measurement, and for specific settings of the SIGNAL CALIBRATOR OUTPUT ATTENUATOR dial.

Step 8. Vary the SIGNAL CALIBRATOR COARSE TUNING control (6, fig. 12) to obtain the highest meter pointer deflection on the OUTPUT METER (2, fig. 13).

Step 9. In the event that the OUTPUT METER pointer deflects to an off-scale value, reduce the setting of the I. F. GAIN control (7, fig. 13) to obtain an on-scale meter indication, with the calibrating signal maximized by the setting of the SIGNAL CALIBRATOR COARSE TUNING control.

Step 10. Vary the SIGNAL CALIBRATOR FINE TUNING control (3, fig. 12) to obtain the highest meter pointer deflection on the OUTPUT METER. Reduce the setting of the I. F. GAIN control (7, fig. 13) further, if necessary, to maintain an on-scale meter pointer indication.

Step 11. Observe the meter indication on the POWER MONITOR meter (5, fig. 13). If the pointer has shifted from the CAL mark, first check the POWER MONITOR meter pointer for zero deflection (steps 1 through 4). Then return the pointer to the CAL mark by readjusting the SIGNAL CALIBRATOR POWER SET control (7, fig. 12). Be sure to reset the SIGNAL CALIBRATOR OUTPUT ATTENUATOR control (5, fig. 12) to obtain a proper MICROVOLTS dial indication, as described in step 6, above.

Step 12. Rotate the Output Meter Function Selector switch (1, fig. 13) to the ZERO SET position. Readjust the setting of the Output Meter ZERO SET control (3, fig. 13) to obtain a zero pointer deflection.

Step 13. Rotate the Output Meter Function Selector switch (1, fig. 13) to the AVERAGE position.

Step 14. Vary the setting of the I. F. GAIN control (7, fig. 13) to obtain a full-scale indication on the OUTPUT METER (2, fig. 13).

Step 15. Rotate the "function selector" (20, fig. 13) to the EI M. position.

Step 16. Observe the pointer deflection on the OUTPUT METER (2, fig. 13). This deflection is the indication of the voltage of the incoming rf signal.

16. SUBSTITUTION METHOD FOR MEASURING AVERAGE POWER OR VOLTAGE LEVEL.

NOTE

The substitution method, covered below, is a more accurate means of measurement, since the possibility of output meter scale tracking error is disregarded.

a. To use the substitution method for measuring the intensity of the incoming rf signal, proceed as outlined in steps 1 through 16 of paragraph 15, immediately above. Then perform the following additional steps:

Step 1. Rotate the "function selector" (20, fig. 13) to the CAL.-SIG. GEN. position.

Step 2. Vary the setting of the SIGNAL CALIBRATOR OUTPUT ATTENUATOR control (5, fig. 12) to reduce the pointer deflection on the OUTPUT METER to the same indication as that for the incoming rf signal. (See step 16 of paragraph 15.)

Step 3. Read the true value of the incoming rf signal from the SIGNAL CALIBRATOR OUTPUT ATTENUATOR dial (5, fig. 12), as corrected by the charts supplied with the equipment.

17. OPERATING PROCEDURE FOR MEASURING POWER OF HIGH LEVEL SIGNALS.

a. In the event that a high-level incoming rf signal requires the INPUT ATTENUATOR selector (17, fig. 13) to be placed in either the 60 db x1000 or 80 db x10,000 position to obtain an on-scale indication on the OUTPUT METER (2, fig. 13), proceed as outlined in the following steps:

Step 1. Rotate the INPUT ATTENUATOR switch (17, fig. 13) to the 40 db x100 position, and proceed as outlined in paragraph 15 (full-scale calibration method for measuring power level). In other words, calibrate the instrument for 100,000 microvolts full-scale indication, as corrected by the charts supplied with the equipment.

Step 2. After obtaining a full-scale indication on the OUTPUT METER while using the signal calibrator as the signal source, rotate the "function selector" (20, fig. 13) to the F.I.M. position.

Step 3. Rotate the INPUT ATTENUATOR switch (17, fig. 13) to the first position beyond its 40 db x100 setting which permits the incoming rf signal voltage indication to be brought on-scale.

Step 4. Read the voltage indication on the OUTPUT METER, applying the proper attenuation factor (obtained from the setting of the INPUT ATTENUATOR switch), and the correction from the charts supplied with the equipment. For example, multiply the indication on the OUTPUT METER by a factor of 10 (adding 20 db) when the INPUT ATTENUATOR switch is rotated to the 60 db x1000 position. Multiply by a factor of 100 (adding 40 db) when the INPUT ATTENUATOR switch is rotated to the 80 db x10,000 position.

18. OPERATING PROCEDURE FOR MEASURING QUASI-PEAK VALUE OF SIGNAL.

NOTE

Quasi-peak measurements are measurements in which a fraction of the peak of the i-f amplifier output voltage is determined. The size of the fraction is directly proportional to the ratio of discharge time-constant to charge time-constant of the weighted detector circuit.

Step 1. Determine the frequency of the incoming rf signal, as outlined in paragraph 14 (operating procedure).

Step 2. Calibrate the instrument as outlined in paragraph 15 (full-scale calibration method), steps 1 through 14 only.

Step 3. After calibrating the instrument, rotate the Output Meter Function Selector switch (1, fig. 13) to the QUASI-PEAK position.

Step 4. Apply the incoming rf signal to the metering circuit by rotating the "function selector" (20, fig. 13) to the F. I. M. position; then observe the pointer deflection on the OUTPUT METER. For high-level signals, refer to paragraph 17.

NOTE

Do not use the substitution method, as outlined in paragraph 16, for calibrating the instrument when quasi-peak measurements are desired.

19. OPERATING PROCEDURE FOR MEASURING PEAK VALUE OF SIGNAL.

Step 1. Determine the frequency of the incoming rf signal, as outlined in paragraph 14 (operating procedure).

Step 2. Rotate the Output Meter Function Selector switch (1, fig. 13) to the PEAK position.

Step 3 Rotate the INPUT ATTENUATOR switch (17, fig. 13) to the 0 db X1 position. Plug a headset into the AUDIO OUT jack (13, fig. 13) and tune in the incoming rf signal for the loudest aural indication.

Step 4. Advance the setting of the SLIDEBACK control (8, fig. 13). This action will determine if the detected audio output of the incoming signal can be cancelled out, with a slideback indication not exceeding full-scale on the OUTPUT METER (2, fig. 13). If cancellation of the signal occurs, keep the INPUT ATTENUATOR switch at the 0 db x1 setting and proceed as directed in the following steps.

NOTE

If the audio detected note of the incoming rf signal cannot be cut off within a full-scale indication on the OUTPUT METER, rotate the INPUT ATTENUATOR switch to its next higher setting. Now advance the SLIDEBACK control again, to determine if the detected signal can be cut off. In all cases, place the INPUT ATTENUATOR switch at that setting which permits the SLIDEBACK control to cut off the detected rf signal, within a full-scale indication on the OUTPUT METER.

Step 5. Calibrate the instrument as outlined in paragraph 15 (full-scale calibration method), steps 1 through 15 only.

Step 6. Rotate the SLIDEBACK control (8, fig. 13) fully counterclockwise.

Step 7. Adjust the AUDIO GAIN control (9, fig. 13) to obtain a comfortable intensity of signal, as monitored in a headset connected to the AUDIO OUT jack (13, fig. 13).

Step 8. Rotate the Output Meter Function Selector switch (1, fig. 13) to the PEAK position.

Step 9. Slowly rotate the SLIDEBACK control clockwise, until the sound in the headset just disappears. Slow advancement of the SLIDEBACK control,

in the region of signal cutoff, is necessary in order to avoid overshooting of the cutoff point, due to inertia in the slideback system.

NOTE

As the region of signal cutoff is approached, the audio output level will rapidly decrease. For the most accurate setting of the SLIDEBACK control and for the precise point of signal cutoff, the AUDIO GAIN control must be progressively rotated clockwise to full on at the signal cutoff point.

Step 10. Recheck the cutoff point by reducing the SLIDEBACK control setting to slightly below cutoff point, and then reestablishing the cutoff point.

NOTE

Step 10 is particularly necessary in those cases where the peak value of a signal, with irregular peak amplitude, must be determined. The requirements for the peak measurements will, however, determine whether the average peak value or the random peak value is measured.

Step 11. Observe the pointer deflection on the OUTPUT METER (2, fig. 13) to determine the indicated peak value of the incoming rf signal.

20. MICROWAVE RECEPTION TEST PROCEDURES.

The reception and signal monitoring capabilities of sensitive microwave receiving equipment permit its application to a wide variety of field and laboratory measurements. Its basic functions are to detect the presence and frequency of rf energy and to determine its relative or absolute input power level. Data thus received may be monitored through audio, video or recorder circuitry for analysis and evaluation.

21. SENSITIVE INDICATOR.

The four basic procedures for attenuation measurements (i-f substitution, rf substitution, calibrated signal generator methods, and receiver meter reading) likewise apply to the other measurements under this paragraph 21.

a. Attenuator Characteristics

Figures 15, 16 and 17 show typical test setups for making accurate rf attenuation measurements.

(1) I-F Substitution

The standard i-f attenuator, calibrated at the receiver's 140-mc i-f, is interposed between the 140 MC OUT and 140 MC IN jacks of the receiver. Tune the receiver to the signal frequency and adjust the i-f attenuator for a reference deflection on the meter. Remove the attenuator under test and increase the i-f attenuation until the same reference meter reading is obtained. The attenuation in db of the attenuator under test is equal to the difference in the two settings of the i-f attenuator.

A single i-f attenuator, accurately calibrated at the receiver's 140-mc i-f, permits the calibration of rf attenuators throughout the receiver's 1 to 10 Kmc range. Rf attenuators can be calibrated to a level of 10 db above the maximum

FIGURE 15 ATTENUATOR MEASUREMENT I-F SUBSTITUTION, TEST SET-UP.

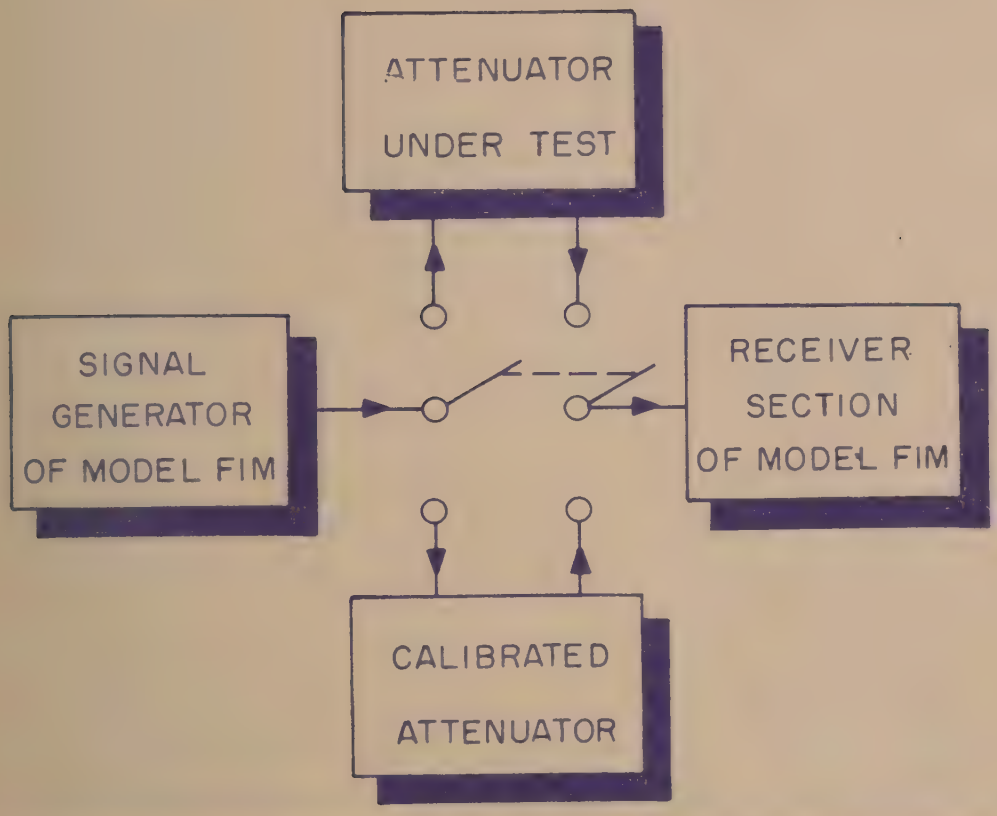


FIGURE 16. ATTENUATOR MEASUREMENTS R-F SUBSTITUTION, TEST SET-UP.

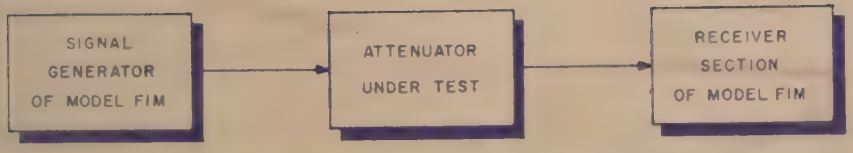


FIGURE 17. ATTENUATOR MEASUREMENTS CALIBRATED SIGNAL GENERATOR AND RECEIVER, TEST SET-UP.

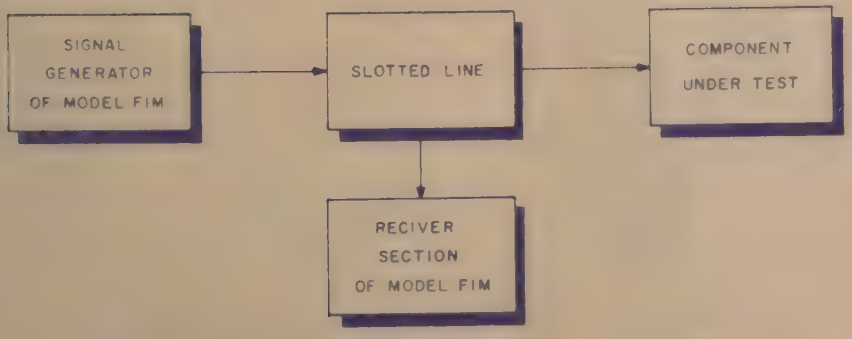


FIGURE 18. SWR MEASUREMENTS, TEST SET-UP.

sensitivity of the receiver, with an accuracy equal to that of the standard i-f attenuator.

(2) Rf Substitution

Insert the unknown rf attenuator in the test setup and obtain a reference deflection on the receiver meter. Replace the unknown attenuator with a standard calibrated rf attenuator and adjust for the same reference deflection. The attenuation of the unknown rf attenuator is equal to that of the adjusted standard attenuator.

(3) Calibrated Signal Generator Method

Obtain a reference deflection on the receiver meter. Record the output level of the signal generator. Insert the rf attenuator and adjust the generator's output level for the same reference deflection. The attenuation of the unknown rf attenuator is equal to the difference in the two output settings of the signal generator.

(4) Receiver Meter

With the unknown attenuator inserted in the test setup, record a reference deflection of the receiver panel meter. Then remove the unknown attenuator and record the new deflection of the receiver meter. The attenuation of the unknown rf attenuator in db is equal to the difference in the two meter readings.

b. Gain Characteristics

The gain of traveling wave tubes is measured with the same setup as in steps (1), (2) and (3) using similar procedures except that the TWT is substituted for the rf attenuator.

c. SWR Measurements

Figure 18 shows the setup for making SWR measurements. Tune the receiver to the signal frequency. Move the probe along the slotted line until maximum and minimum deflections are indicated on the receiver meter. The SWR in db is equal to the difference in the two meter readings.

Because of its narrow-band preselector, the receiver will not respond to harmonics and spurious signals from the source, which might otherwise cause errors. The receiver's large dynamic range allows standing wave ratios as low as 1/2 db and as high as 70 db to be measured. When measuring low SWR the probe can be loosely coupled to the slotted line because of the high sensitivity of the receiver.

d. Rf Leakage and Interference Measurements

Figure 19 shows the setup for determining the absolute leakage level of microwave equipment. With the Function Selector switch adjusted to accept the antenna signal, use the antenna to search around connectors, screw joints, or any other suspected source of leakage. Either a horn or dipole antenna may be used. When a signal is detected on the receiver meter, record the level of deflection. Switch to the signal generator output and adjust the generator's output level for the same deflection on the receiver meter. The absolute power level of the leakage signal at the antenna output is equal to the output level of the signal generator, as indicated on the generator's front panel meter. To convert to field intensity, apply the formula in Section 23-a.

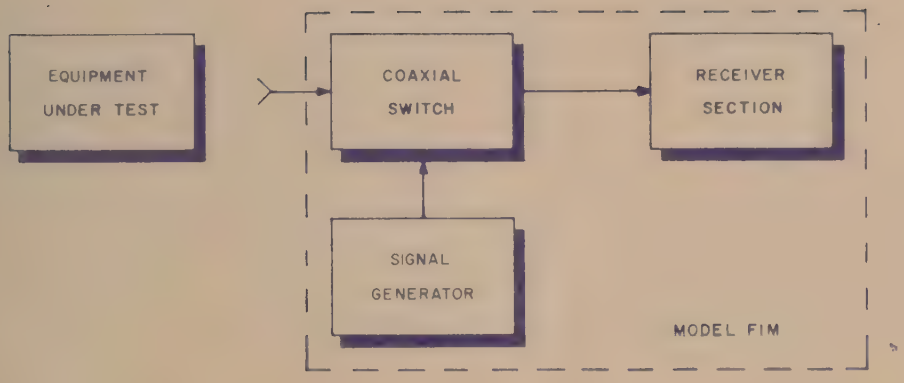


FIGURE 19. RF LEAKAGE AND INTERFERENCE MEASUREMENTS, TEST SET-UP.

FIGURE 20. MICROWAVE FILTER CHARACTERISTICS, TEST SET-UP.

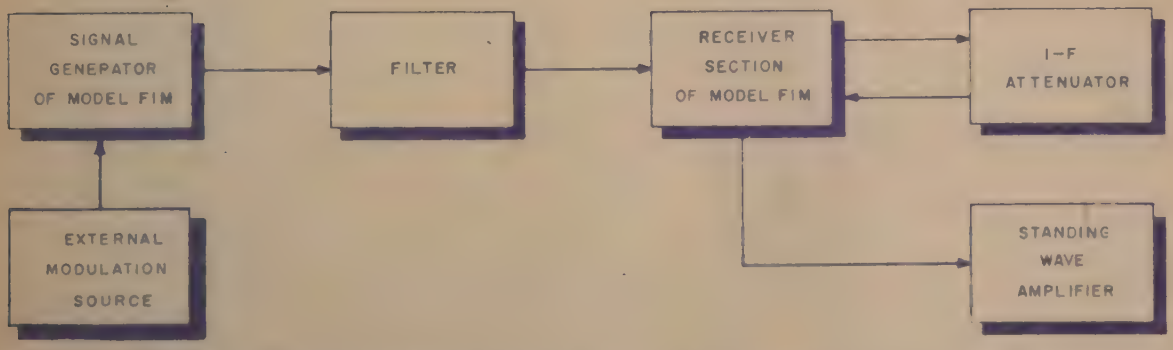


FIGURE 21. MODIFIED MICROWAVE FILTER CHARACTERISTICS, TEST SET-UP TO EXTEND RANGE FROM 60db TO 100db.

As an alternate method, first calibrate the receiver to read absolute power. This is done by connecting the generator directly to the receiver and varying the generator's calibrated power output. At each power level record the corresponddeflection of the receiver meter. Absolute leakage level can now be read directly from the receiver's power monitor.

e. Microwave Filter Characteristics

Figure 20 shows the setup for measuring characteristics of filters. Tune the receiver to the generator frequency and record the reading of the receiver meter. With the generator output level kept constant, vary the generator frequency. Tune the receiver to each new generator frequency and record the corresponding meter reading. Skirt selectivity can be measured to 60 db from the center band response.

To extend the range of measurements to 100 db, the setup is modified as shown in Figure 21.

The standing wave amplifier is connected to the VIDEO OUT jack of the receiver. Adjust the signal generator for maximum calibrated output power and adjust its modulation to correspond to that of the amplifier (1,000 cps). Remove the filter and note the noise level of the system. Adjust the i-f attenuation so that the standing wave amplifier reads 6 db above the noise level. With the generator output kept constant, vary the frequency over the desired band. At each frequency, insert the filter into the system and note the reading of the standing wave amplifier. Remove the filter and record the additional i-f attenuation necessary to restore this reading. The additional i-f attenuation corresponds to the relative attenuation between the responses at the various frequencies.

f. Q and Bandwidth of Microwave Cavities

Connect the cavity to be checked between a signal generator and the receiver. Tune the signal generator, the cavity, and the receiver to the frequency at which the test is to be conducted. Detune the generator and receiver together to the 3 db power level on either side of the center frequency. The bandwidth of the cavity is equal to the difference in the frequency readings at the 3 db power points.

Medium and low Q cavities can be checked with the microwave receiver using this method. The 6 db bandwidth (Δ f) of the final i-f determines the resolution of the receiver and the highest Q that can be measured with maximum accuracy.

$$Q \leq \frac{f}{10 \Delta f}$$

g. Noise Figure of Microwave Amplifiers

Figure 22 shows the setup for measuring the noise figure of an rf amplifier. Overall noise figure of the system may be plotted on the graph of figure 23.

First the gain of the rf amplifier must be determined. To do this, adjust the signal generator output for the same reference deflection of the receiver meter with the amplifier in and out of the test setup. The gain (G) of the amplifier is equal to the difference in the two output settings.

To determine the noise figure of the receiver, measure the sensitivity P_r (signal plus noise equals twice the noise). Knowing the receiver bandwidth Δ f, substitute in the following formula:

$$F_r = 10 \log \left(\frac{Pr}{KT \Delta f} \right)$$

where:

F_r - Noise figure of receiver alone

P_r = Receiver power sensitivity in watts

FIGURE 22. MICROWAVE AMPLIFIER NOISE FIGURE, TEST SET-UP.

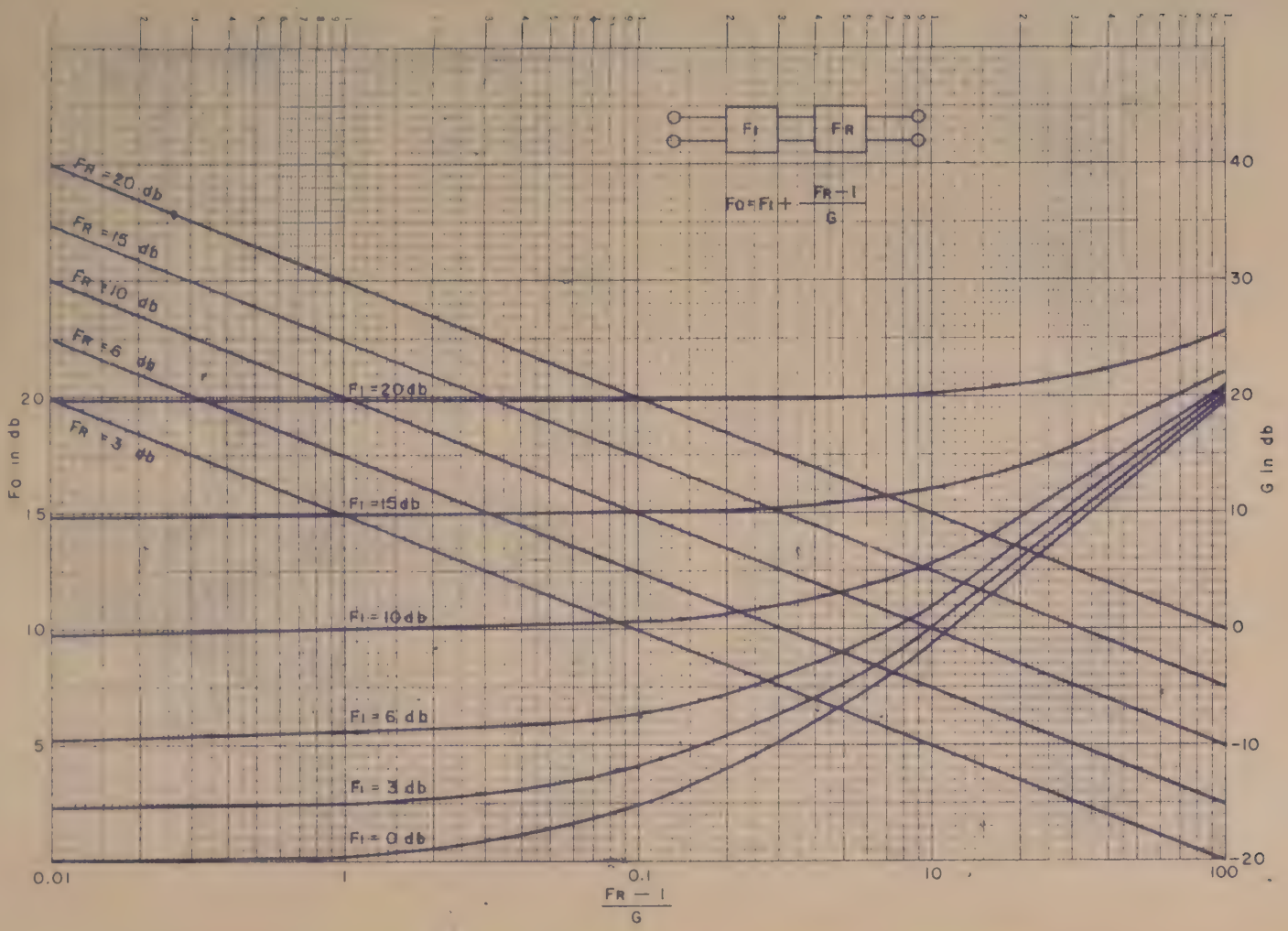


FIGURE 23. NOISE FIGURE IN CASCADED NETWORKS

EXPLANATION OF GRAPH SHOWN IN FIGURE 23.

When an amplifier is used ahead of a receiver (see Section 22-g and figure 22), the overall noise figure is determined by the noise figure of the receiver as well as the gain and noise figure of the amplifier:

$$F_O = F_1 + \frac{F_R - 1}{G}$$

Where F_O = overall noise figure

F_1 = noise figure of the amplifier

F_R = noise figure of the receiver

G = gain of the amplifier

This chart (figure 23) shows overall noise figure as a function of F_1, F_R and G

HOW TO USE IT: Given, for example, an amplifier with a gain of 10 db and a noise figure of 3 db, and a receiver noise figure of 20 db.

Find $\frac{F_R - 1}{G}$ by following the F_R line (20 db) to its point of intersection with the G line at 10 db, read on the right hand vertical scale. This shows a value of 10 on the bottom horizontal scale. The overall noise figure F_O is found on the left-hand vertical scale at a point corresponding to $\frac{F_R - 1}{G}$ (10) on the F_1 (3 db) curve. The value of F_O at this point on the left-hand scale is 11 db.

T = Effective temperature in degrees Kelvin
f = Bandwidth in cycles per second
K = Boltzmann's constant:

$$1.374 \cdot 10^{-23} \quad \frac{(\text{joules})}{(\text{degrees K})}$$

Measure the noise figure of the system (F_0). The noise figure of the rf amplifier (F_1) is calculated

$$F_1 = F_0 - \frac{F_r - 1}{G}$$

(Refer also to figure 23.)

h. Shielding Efficiency of Screen Room - High Attenuation

Locate the receiver and its antenna in the center of the room. Outside the room and in line with the receiver and center of open door, set the signal source and its antenna. With the door to the screen room open, orient the antennas and tune the receiver for maximum deflection. Record the meter reading.

Close the screen door and again record the meter reading. The shielding attenuation in db is equal to the difference in the two meter readings.

22. SIGNAL ANALYZER

a. Relative Power of the Harmonics of Signals

To determine the difference in power levels between a fundamental signal and its harmonics, record the reading of the receiver meter with the receiver tuned first to the fundamental, and then to the harmonics in question. At each frequency calibrate the receiver input. The difference in power levels between the fundamental and its harmonics is equal to the difference in the meter readings at their respective frequencies.

b. Broadband Noise Measurement

Figure 24 shows the setup for making broadband noise measurements.

FIGURE 24. BROADBAND NOISE MEASUREMENT, TEST SET-UP.

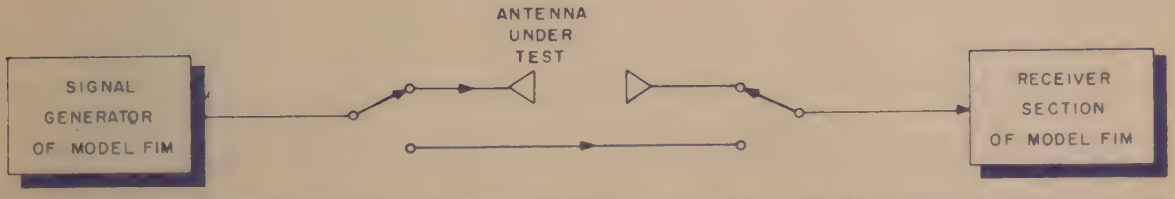


FIGURE 25. ANTENNA FIELD PATTERNS, TEST SET-UP USING THE DIRECT RECEIVER METHOD.

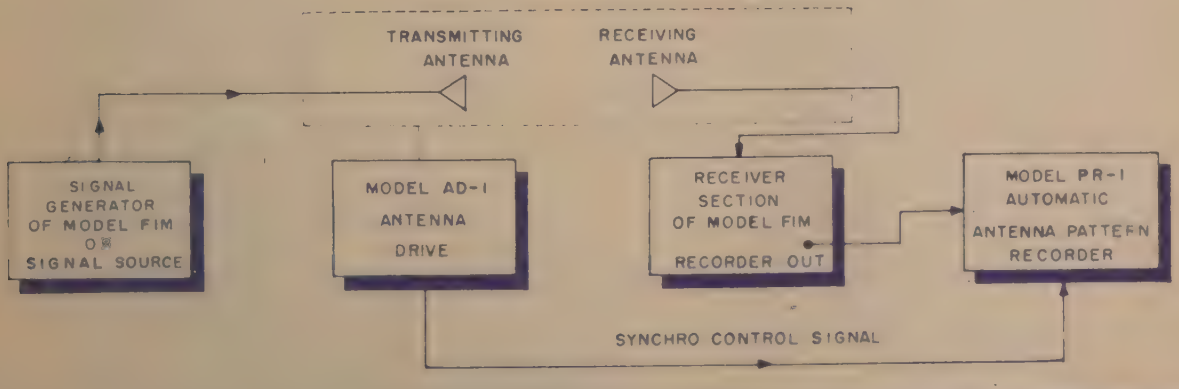


FIGURE 26. ANTENNA FIELD PATTERNS, TEST SET-UP USING AN AUTOMATIC PATTERN RECORDER.

The area is probed with the antenna band carried or mounted on a tripod. To make relative measurements, observe the FIM OUTPUT METER with the Output Meter Function Selector switched to QUASI PEAK position.

To measure the peak value of the rf noise, switch the Output Meter Function Selector to its peak position. Rotate the SLIDEBACK control until aural response is just cut off. The peak value of the rf noise is read directly from the OUTPUT METER.

c. AM Analysis

If the modulation frequency falls within the audio range it can be monitored by a pair of earphones at the AUDIO OUT jack. To analyze the AM envelope, observe the signal on an oscilloscope connected at the receiver's VIDEO OUT jack.

To measure percentage modulation, record as reference readings the receiver meter indication in average and peak output level as indicated in peak position. The percentage modulation of the signal is then:

$$\frac{E_{peak} - E_{average}}{E_{average}} \times 100$$

23. RECEIVER

a. Propagation Studies

To obtain field intensity contours, use the Polarad Model FIM Field Intensity Meter, which has a calibrated output.

Choose a point of relatively high intensity as a central location. Proceed radially outward, and at fixed intervals record the power input to the receiver.

Calculate the field intensity (E) at any point, from the expression

$$E = \frac{4\pi}{\lambda} \sqrt{\frac{(30)\quad(P)}{(G)}}$$

where: P = Power input to the receiver (watts)

G = Antenna gain

To obtain field intensity contours, plot the measurement points on polar coordinate paper and connect points of equal intensity.

b. Site Locations

To determine the feasibility of site location for microwave relay systems, set up the receiver at the various proposed sites. The relative signal strengths are compared at various times during the day. To obtain a record of field intensity over an extended period of time, use the receiver in conjunction with an automatic recorder.

c. Direction Finding - Countermeasures

To search for signals, use the omnidirectional broadband antenna. Tune the receiver until a signal is detected on the receiver meter. To determine the angle of arrival switch to a narrow beam antenna. Slowly rotate the antenna until the signal is again indicated on the meter. The accuracy of the observed bearing is determined by the sharpness of the antenna pattern.

24. ANTENNA PATTERN MEASUREMENTS

a. Antenna Field Patterns

(1) Direct Receiver Method

Figure 25 shows the setup for making antenna pattern measurements. Adjust the FIM receiver for operation at highest sensitivity. With the antennas lined up visually, increase the generator output until a deflection is indicated on the receiver meter. Vary the antennas in both their horizontal and vertical positions until a maximum deflection is obtained. Now adjust the generator output so that the meter is deflected full scale. Rotate the receiving antenna and record on polar coordinate paper a plot of meter reading vs. angle of rotation.

The FIM provides a dynamic range of 130 db. Record on polar coordinate paper a plot of meter reading (in db) vs. angle of rotation.

(2) Automatic Pattern Recorder

Antenna pattern measurements may be recorded automatically by using an automatic pattern recorder in conjunction with the FIM.

The recorder is plugged into the receiver's RECORDER OUT jack. The chart is driven in synchronism with the rotating antenna, while the pen duplicates the reading of the receiver meter. The resultant curve is a plot of degrees rotation vs. receiver output.

Antenna pattern measurements over the frequency range 1 kmc to 10 kmc can be made by combining the receiver section of Model FIM, the Model AD-1 Antenna Drive, and the Model PR-1 Antenna Pattern Recorder, as shown in figure 26.

25. TEST PROCEDURES TO MILITARY SPECIFICATIONS

a. Introduction

As an aid to the equipment manufacturer who is concerned with taking interference and susceptibility measurements to meet government specifications, step-by-step procedures are outlined in the paragraphs below. These procedures were written in compliance with the specification MIL-I-006181C(USAF) or MIL-I-26600 (USAF). This specification is typical of the other military specifications on interference at microwave frequencies. A chart is included as table X which illustrates the differences between the applicable specifications.

b. Radiated Interference Measurement

The procedure for making measurements of radiated interference is given in the following paragraphs.

Choose a suitable location for conduction of the test. An anechoic test chamber, or other shielded enclosure free from reflections, is preferable. Broadband-absorbent materials, such as loosely-spun mats, are available for lining the interior of a screen room to provide an area which is free from extraneous signals. By this means, power reflections may be reduced to less than two percent.

However, if a microwave test chamber is not conveniently available, measurements may be performed in any suitable location, provided that the ambient interference level is at least six decibels below the allowable specified interference limit.

TABLE X.

COMPARISON OF INTERFERENCE SPECIFICATIONS

Ambient Interference Level	MIL-I-006181C(USAF) or MIL-I-26600(USAF) 6 db below specified limit	WDD-M-PRO-2 6 db below specified limit	HCD-487 6 db below specified limit
Radiated Interference (narrow-band)	30 db above 1 uv	30 db above 1 uv	40 db above 1 uv
Radiated Interference (broadband)	15 db above 1 uv/mc	15 db above 1 uv/mc	Not Required
Conducted Interference	Not Required	Not Required	Not Required
Susceptibility to Radiated Interference	0.1V* Gen. Output (50 ohms)	0.1V Gen. Output (50 ohms)	0.1V Gen. Output
Susceptibility to Conducted Interference	0.1V* Gen. Output (50 ohms)	0.1V Gen. Output (50 ohms)	0.1V Gen. Output
Receiver Front-End Rejection (narrow-band)	80 db (outside tunable range) 60 db (within tuning range)	80 db (outside tunable range) 60 db (within tuning range)	60 db (minimum)
Transmitter Key-Down (D_F = Fundamental Frequency) F = Test Frequency) P = Transmitter Out. Power D = Allowable Level	$D = D_F - (80+10 \log P)$*	$D = D_F - (80+10 \text{ Log } P)$*	60 db below rated output

*Test not required for Class II equipment.

TABLE X.

COMPARISON OF INTERFERENCE SPECIFICATIONS (Continued)

Ambient Interference Level	MIL-I-006181C(USAF) or MIL-I-26600(USAF) 6 db below specified limit	WDD-M-PRO-2 6 db below specified limit	HCD-487 6 db below specified limit
Transmitter Key-Up (narrow-band)	40 db above 1 uv*	40 db above 1 uv	200 uuwatts
Transmitter Key-Up (broadband)	60 db above 1 uv*	60 db above 1 uv	200 uuwatts
Receiver Local Oscillator Radiation (narrow-band)	40 db above 1 uv* (100 uv)	200 uuwatts (100 uv across 50 ohms) 2.0 uuwatts (10 uv across 50 ohms	200 uuwatts Not Specified
Receiver Local Oscillator Radiation (broadband)	20 db** above 1 uv/mc* (10 uv)		

*Test not required for Class II equipment.

**To be changed to 60 db above 1 uv/mc in forthcoming Air Force Specification MIL-I-26600(USAF).

Decide whether the equipment under test belongs to Class I, Class II, or Class III. The three classes are defined in the specification as: Class I includes special purpose equipment installed in, or closely associated with, airborne weapons systems; Class II includes equipment intended for direct support of airborne weapons systems; and Class III includes equipment used with a surface system. Refer to the specification for the exact test setup to be used with each class of equipment.

Table XI gives a summary of the distance between the antenna and the interference source and the proper antenna orientation. Figure 27 is a simplified block diagram of the test setup and figures 28, 29, and 30 show actual test setups for each of the three classes of equipment.

When the equipment has been set up, search the complete frequency range for the presence of an interference signal. (The required frequency range is given in the specification.) The frequencies at which maximum interference is obtained are selected as the test frequencies. A minimum of three per octave is required.

NOTE

If the equipment under test contains oscillator circuits, the test-set should be tuned to the fundamental frequency and all harmonic frequencies of these oscillator circuits.

Throughout this searching operation, the OUTPUT METER FUNCTION SELECTOR switch is set in the QUASI-PEAK position, so that the instrument will respond to any broadband interference which may be present, as well as to narrow band interference. The presence of interference is indicated by the OUTPUT METER on the Monitor Unit front panel.

Once the presence of an interference signal has been established, and its frequency (or frequencies) determined, ascertain whether the interference is narrow band (cw) or broadband (pulsed cw). One method is to watch the indication of the OUTPUT METER as the FIM is tuned through a range of frequencies. If this indication remains constant over a broad range of frequencies, the interference may be assumed to be broadband. If, on the other hand, there appears to be a resonant peak over a narrow range of frequencies, the interference may be assumed to be narrow band.

If the interference signal is narrow band, place the OUTPUT METER FUNCTION SELECTOR switch in the AVERAGE position, and take the measurement by reading the OUTPUT METER on the db over one microvolt scale. If the interference level is below the maximum allowable limit of 30 db above one microvolt, the equipment has met the requirements with regard to radiated narrow band interference.

If the interference signal is broadband, place the OUTPUT METER FUNCTION SELECTOR switch in the PEAK position, and adjust the SLIDEBACK control until the sound in the headset just disappears. Then take the measurement by reading the OUTPUT METER on the db over one microvolt/megacycle scale (red scale). If the interference level is below the maximum allowable limit of 15 db above one microvolt/megacycle, the equipment has met the requirements with regard to radiated broadband interference.

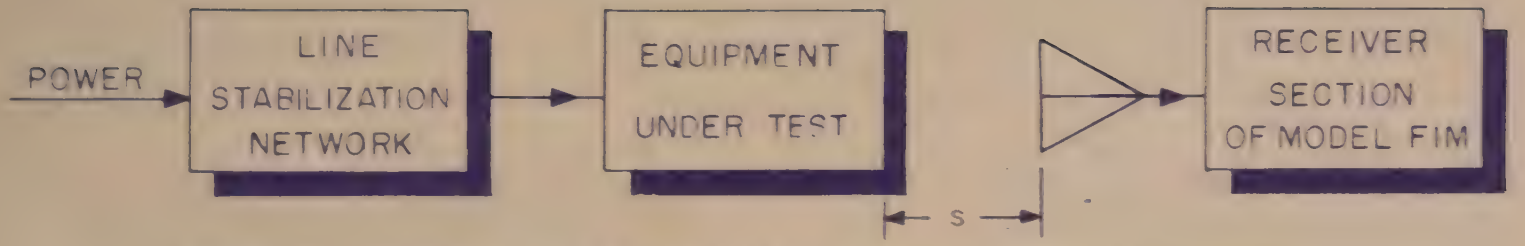


Figure 27. Block Diagram of Test Set-Up for Measuring Radiated Interference.

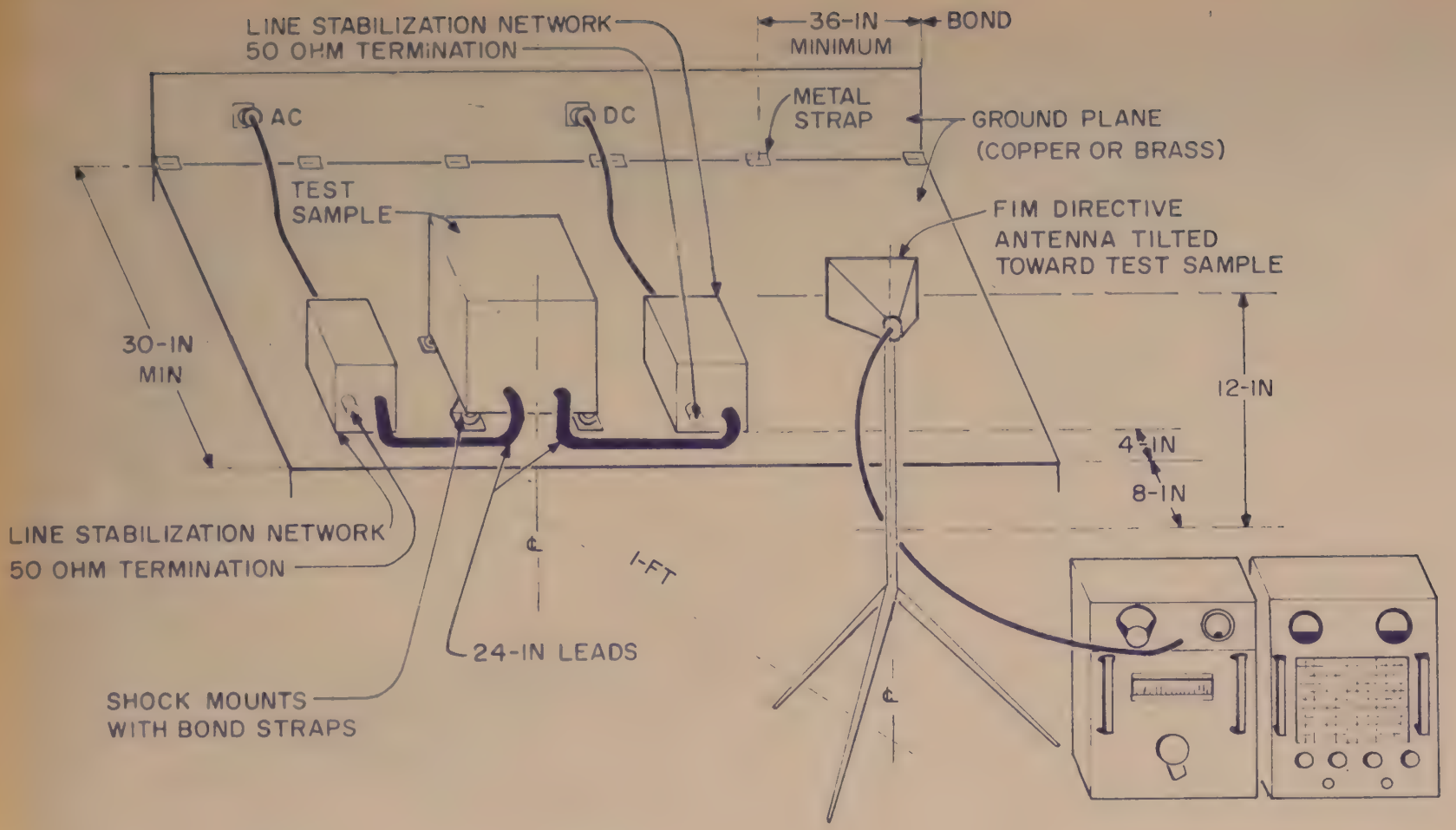


FIGURE 28. TEST SETUP FOR MEASURING RADIATED INTERFERENCE FROM CLASS I (AIRBORNE) EQUIPMENT.

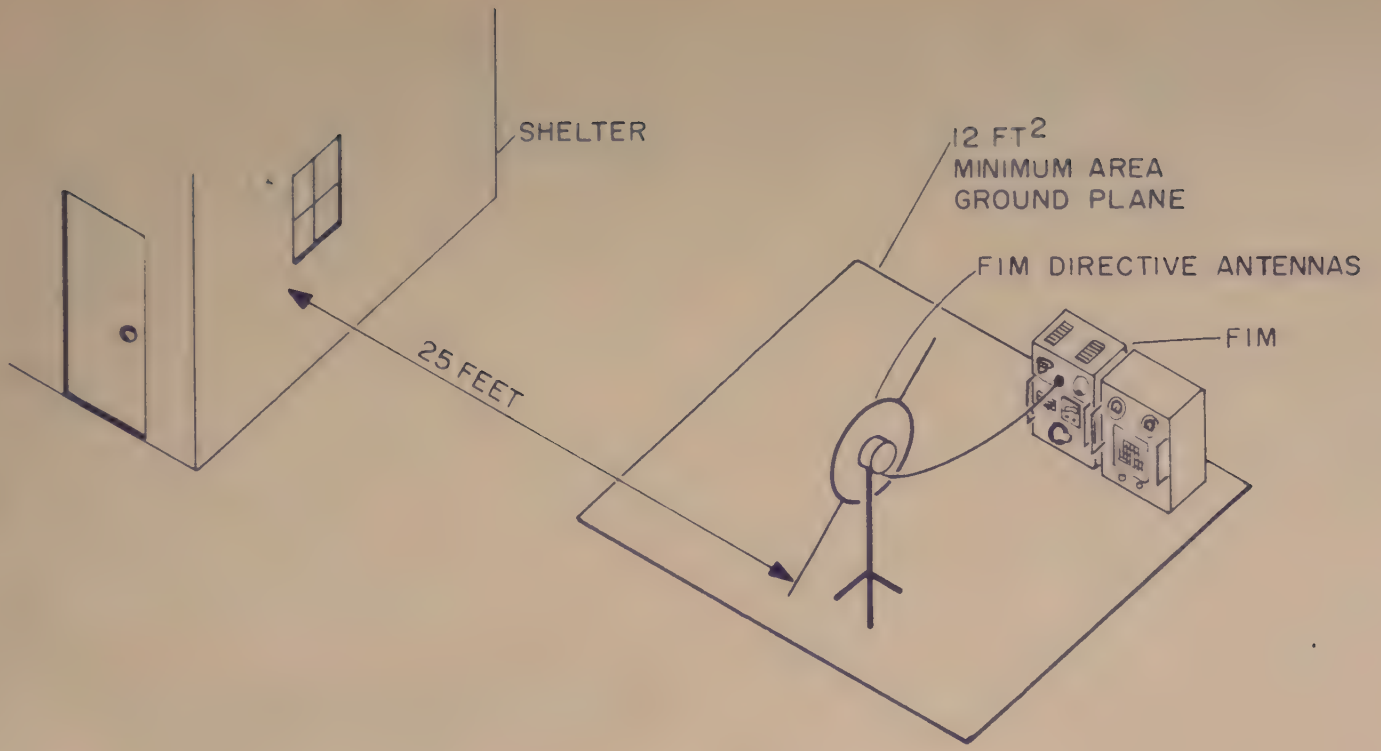


FIGURE 29. TEST SETUP FOR MEASURING RADIATED INTERFERENCE FROM CLASS II (GROUND-SUPPORT) EQUIPMENT.

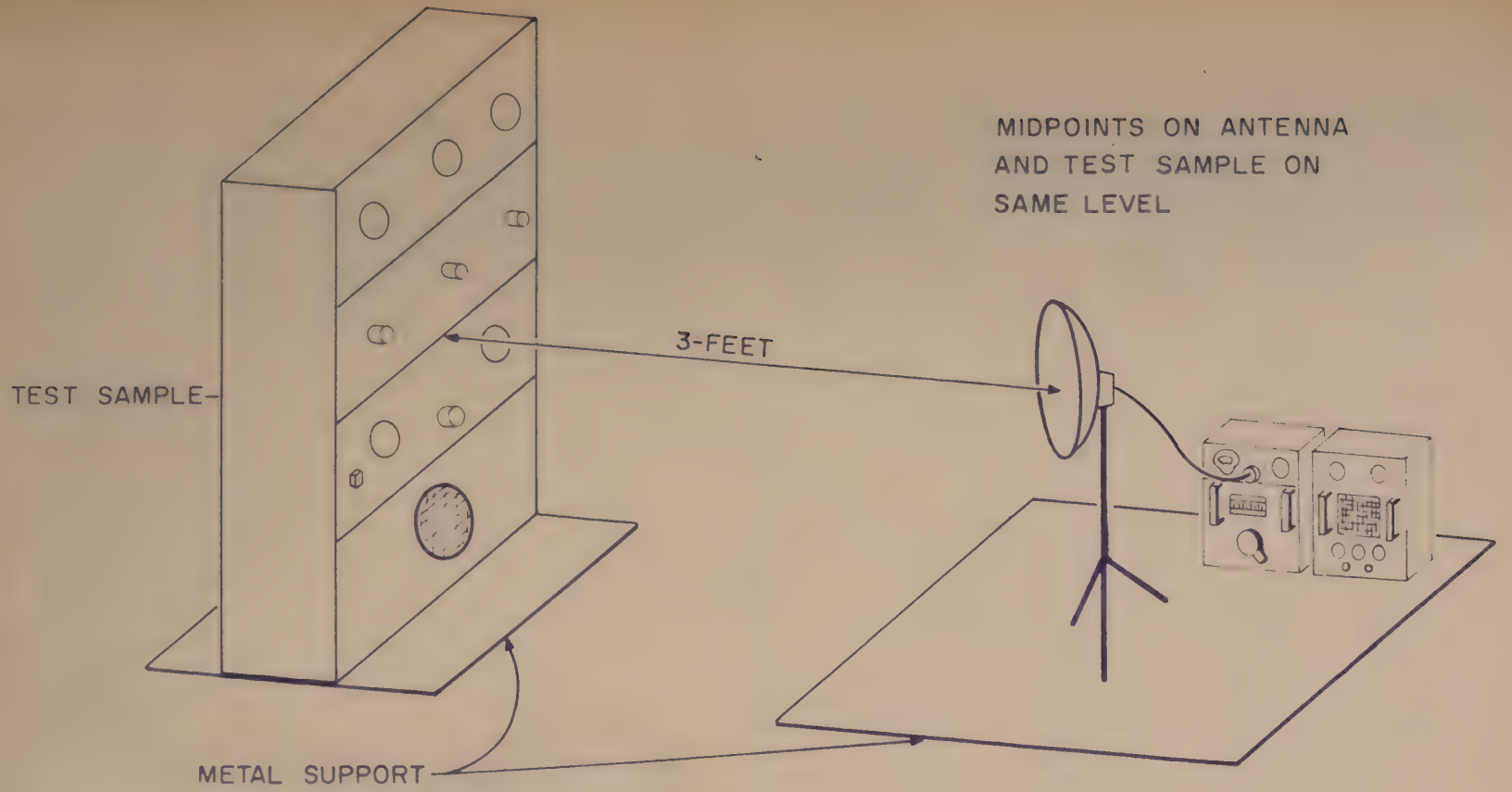


FIGURE 30. TEST SETUP FOR MEASURING RADIATED INTERFERENCE FROM CLASS III (SURFACE) EQUIPMENT.

TABLE XI
RADIATED MEASUREMENTS

Class	s	Antenna Orientation
I Test Equipment	1 foot	Tilted toward sample with a height of one foot above table
II Support Equipment	25 feet	Directed toward sample with a 12 square foot minimum ground plane
III Surface Systems	3 feet	Mid-point of antenna and sample on same level

where s = Distance between the antenna and the interference source

NOTE

The military specifications do not require any measurement of conducted interference.

c. Susceptibility to Radiated Interference

In measuring susceptibility in accordance with MIL-I-006181C(USAF), set up the equipment as required by the specification. Figure 31 is a block diagram of the test setup.

With the controls of the unit under test set for the maximum indication of interference, and the signal generator modulated by the type required by the unit, set the signal generator to produce an output of 100,000 microvolts.

Scan the frequency range of 1,000 to 10,000 megacycles with the signal generator and observe any reaction of instrument under test. There should be no indication of malfunctioning, degradation of performance, or change in the indication of the equipment.

d. Susceptibility to Conducted Interference

This test is performed in the same manner as given for susceptibility to radiated interference (see above) with the exception that the output of the signal generator is connected to a line stabilization network. See figure 32 for a block diagram of this test setup.

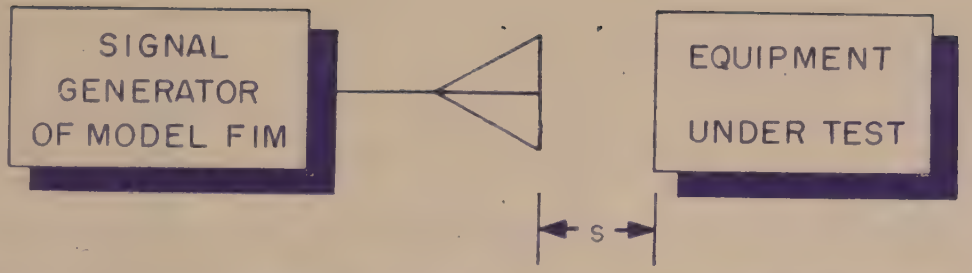


Figure 31. Block Diagram of Test Set-Up for Measuring Susceptibility to Radiated Interference.

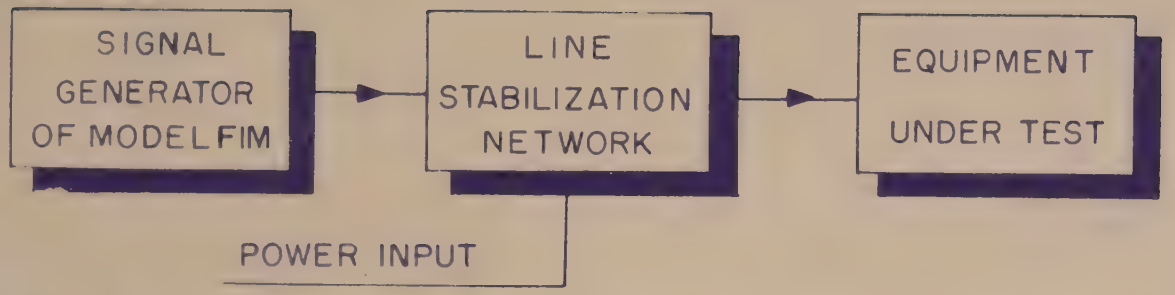


Figure 32. Block Diagram of Test Set-Up for Measuring Susceptibility to Conducted Interference.

e. Receiver Front End Rejection

Front end rejection is the capability of a receiver to reject signals applied to the antenna terminals which are outside of the frequency range to which the receiver is tuned. The units applied to this measurement are decibels.

The procedure used for this test is given in the following paragraphs.

Connect the output of the signal generator to the input of the receiver under test, as shown in figure 33. With the signal generator set for maximum output, scan the frequency range of 1 kmc to 10 kmc. Record the signal at each point in the frequency range at which a response is obtained from the receiver.

The front end rejection may be derived by subtracting the signal generator output required for minimum perceptible signal at the receiver's tuned frequency from the output required for minimum perceptible signal at any other frequency.

f. Antenna-Conducted Spurious Emanations of Transmitters

To meet the requirements of MIL-I-26600(USAF), transmitters must be tested for antenna-conducted spurious emanations in both the "key-down" (transmit) and "key-up" positions. The procedure for taking these measurements is outlined in the following paragraphs.

g. Transmitter Key-Down

With the transmitter connected to a dummy load, provide a means of sampling the transmitter output. (i.e., a directional coupler.) A block diagram of the test setup is given in figure 34.

With the transmitter operating at maximum-rated output, measure and record the level of the fundamental transmitter signal. Slowly tune the test set receiver

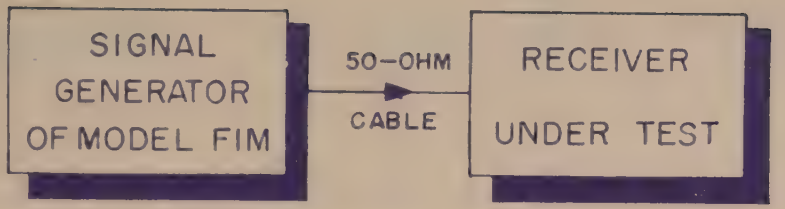


Figure 33. Block Diagram of Test Set-Up for Measuring Front-End Rejection of Receivers.

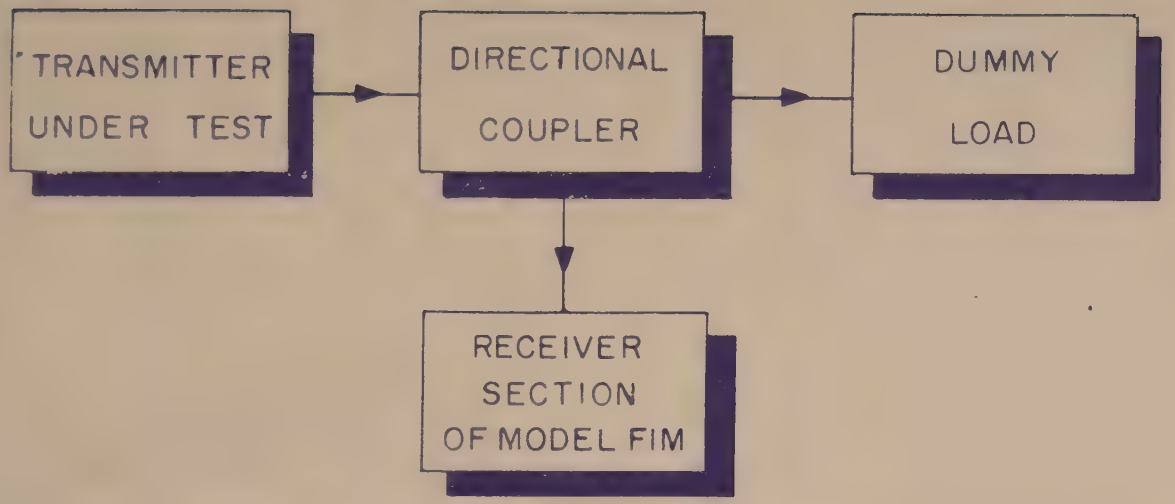


Figure 34. Block Diagram of Test Set-Up for Transmitter Keydown Measurements.

through the required frequency range (1 kmc to 10 kmc.) Give particular attention to anticipated signals or spurious responses from oscillators, frequency multipliers, and other such circuits. The fundamental frequencies and the harmonics, of these frequencies should be investigated, to be sure that they do not exceed the level indicated by the applicable specifications.

h. Transmitter Key-Up or Receiver Local Oscillator Radiation

The procedure for this test is the same as that outlined for transmitter key-up, with the exception that the transmitter is not keyed.

i. Additional Applications for Model FIM

Complete interference and susceptibility measurements are only two of the numerous types of microwave measurements which can be performed with the versatile combination of receiver and calibrated signal generator found in the Model FIM Field Intensity Meter and Receiver. Without requiring any auxiliary equipment, this integrated test set has the following additional applications.

Propagation studies, and the measurement of field intensity contours. Such measurements are important in choosing suitable sites for the construction of microwave relay links.

Measurements of rf leakage from microwave devices, to determine the effectiveness of shielding and other design techniques for reducing radiation and leakage.

Antenna measurements. Field patterns may be obtained, and antenna characteristics, such as gain and phase shifts can be determined.

Signal analysis and countermeasures application. The direction, frequency, relative power, and type of modulation of the unidentified signal may be determined

for decoding purposes, or so that countermeasures may be taken for spot-frequency jamming of the signal.

Measurements of both peak and average values of power from very low level (10^{-11} watts) up to two watts. The relative power of the harmonics of signals, and the peak value of transients, may also be measured.

Measurements of the characteristics of transmitter, receivers, and transponders, e.g., receiver sensitivity, bandwidth, noise figure, local oscillator radiation, image and spurious response rejection, linearity, input impedance, transmitter output power, spurious emission, modulation, leakage, distortion, etc.

General laboratory measurements as an rf voltmeter, or for measuring properties such as attenuation; impedance; frequency; gain; Q; bandwidth; and selectivity curves of microwave cavities, filters, preselectors, and transmission lines; both high and low values of SWR, etc.

When used in conjunction with other equipment, such as the Polarad Model TSA-S Combination Synchroscope-Spectrum Analyzer (which provides a display of energy versus time, and indicates the frequency distribution of the energy), the Model FIM has an even longer list of application. Together, these two instruments provide for complete analysis of any interference signal in terms of absolute power magnitude, rise time, decay time, pulse width, pulse repetition rate, relative amplitudes of main and side lobes, type of modulation, symmetry of spectrum, and other characteristics. Remedial measures are greatly facilitated by such a thorough analysis of the interference signal.

Typical Synchroscope-Spectrum Analyzer displays of pulse signals as a function of time and of frequency are shown in Figure 35.

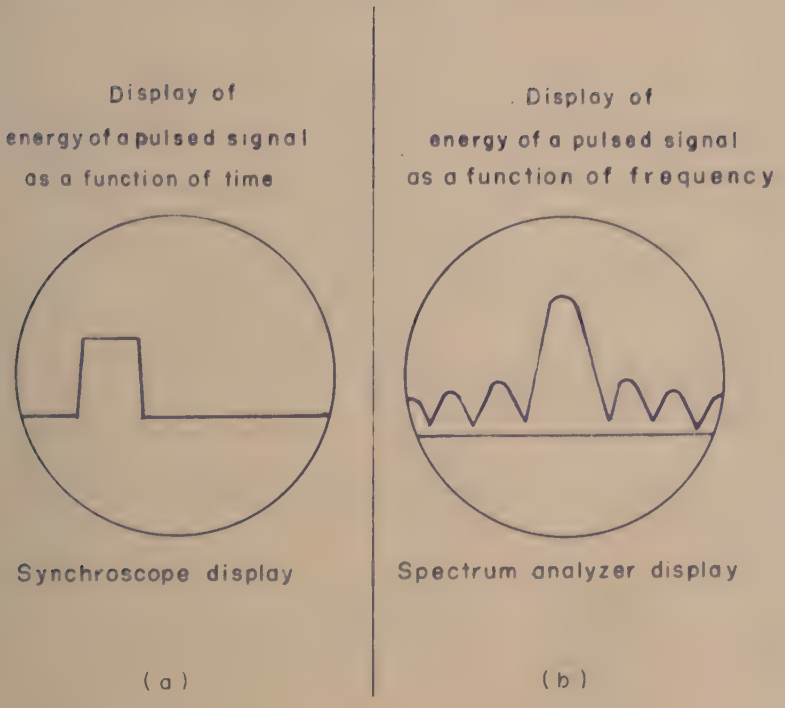


Figure 35. Typical Synchroscope-Spectrum Analyzer Displays of Pulse Signals as a Function of Time and Frequency.

SECTION D

THEORY OF OPERATION

26. GENERAL.

a. The Polarad Field Intensity Meter is basically a highly sensitive microwave superheterodyne receiver covering the frequency range of 1.0 kmc to 10.0 kmc, and includes the following addtional circuitry:

(1) A Signal Calibrator, physically contained within each of the Tuning Units for standardizing the gain of the receiver.

(2) Rf preselection and high-frequency first i-f (at 260 mc) to ensure adequate image and spurious respone rejection.

(3) Calibrated rf and i-f attenuation, in 20 db steps, to extend the basic 10 to 1,000 microvolt range of the instrument to a maximum of 3 volts.

(4) Automatic frequency control (AFC) to compensate for frequency shift.

(5) Automatic gain control (AGC) to provide adequate dynamic range.

(6) A calibrated output voltmeter with three scales (rf microvolts, decibels above one microvolt, and decibels above one microvolt/megacycle).

(7) Weighting circuits for measurements of average, quasi-peak, or peak values of input signals.

(8) Audio, video, and recorder outputs.

(9) Aural tuning aid, to facilitate detection of unmodulated signals.

b. BLOCK DIAGRAM. Figure 36 in this Instruction Manual shows the block diagram of the F.I.M. The rf signal or interference (hereafter called the signal) is applied from the antenna to the RF IN jack on the Monitor Unit front panel. The signal is coupled to the input of a two-position coaxial rf "Function Selector" switch, which functions as follows:

NOTE:

Reference is made to Band 1 Tuning Unit.

(1) In the F.I.M. position, the signal from the antenna is coupled through the coaxial switch contacts to a turret step-attenuator.

(2) In the CAL. SIG. GEN. position, the signal from the antenna is open-circuited, while the output of the signal calibrator is connected by an external cable from the SIG. GEN. OUT jack J409 to the CAL. IN jack J153, and is then coupled through the coaxial switch contacts to the turret step-attenuator.

The signal after passing through the turret step-attenuator is coupled to the input of a variable-tuned, two-cavity preselector. The output of the klystron local oscillator is tracked with the preselector through a mechanical drive system. The system is so designed that the frequency of the local oscillator, at any point within the frequency range, is always separated from the incoming rf signal by 260 mc; the particular Tuning Unit in use determines whether the klystron oscillator is tracked above or below the incoming rf signal (see Table XII).

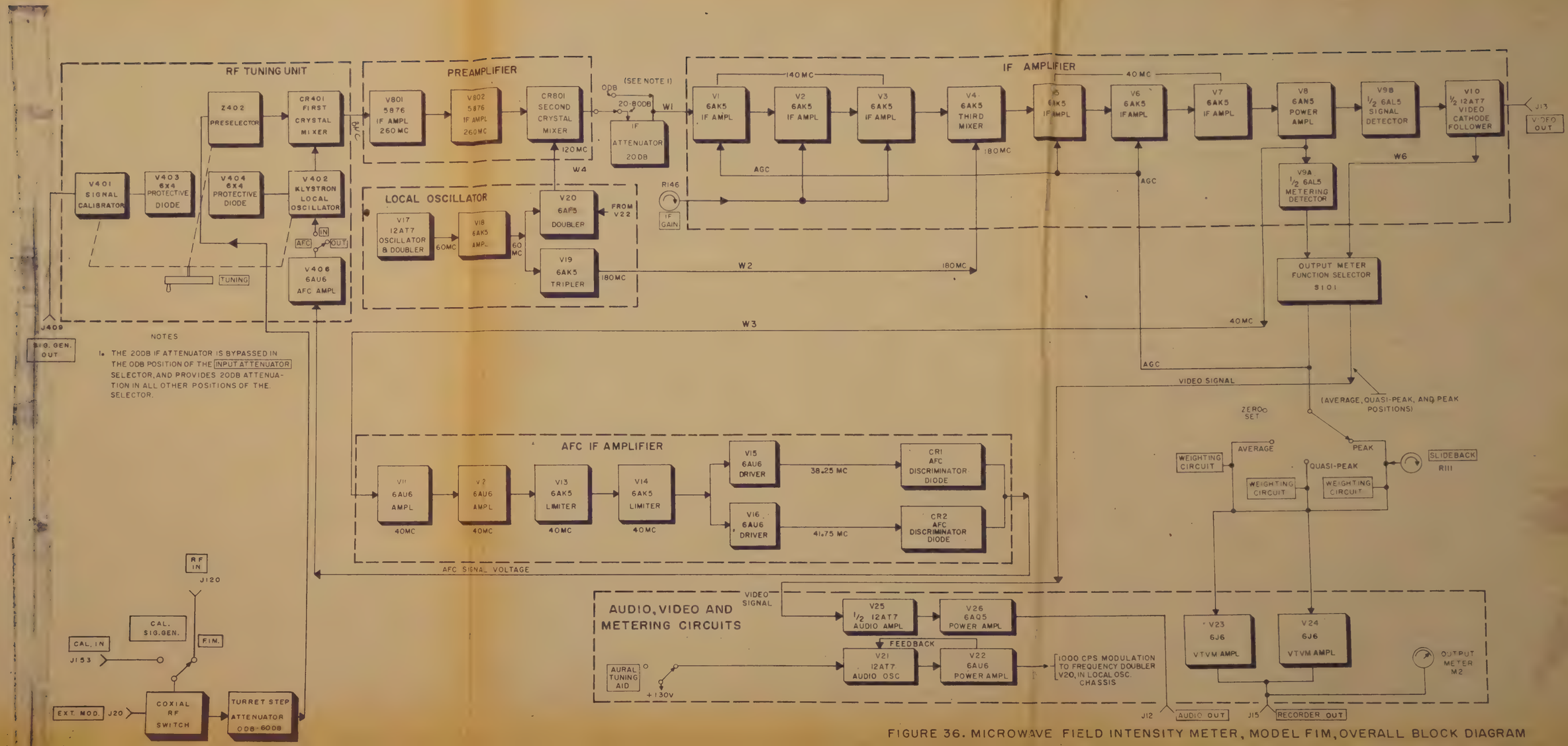


FIGURE 36. MICROWAVE FIELD INTENSITY METER, MODEL FIM, OVERALL BLOCK DIAGRAM

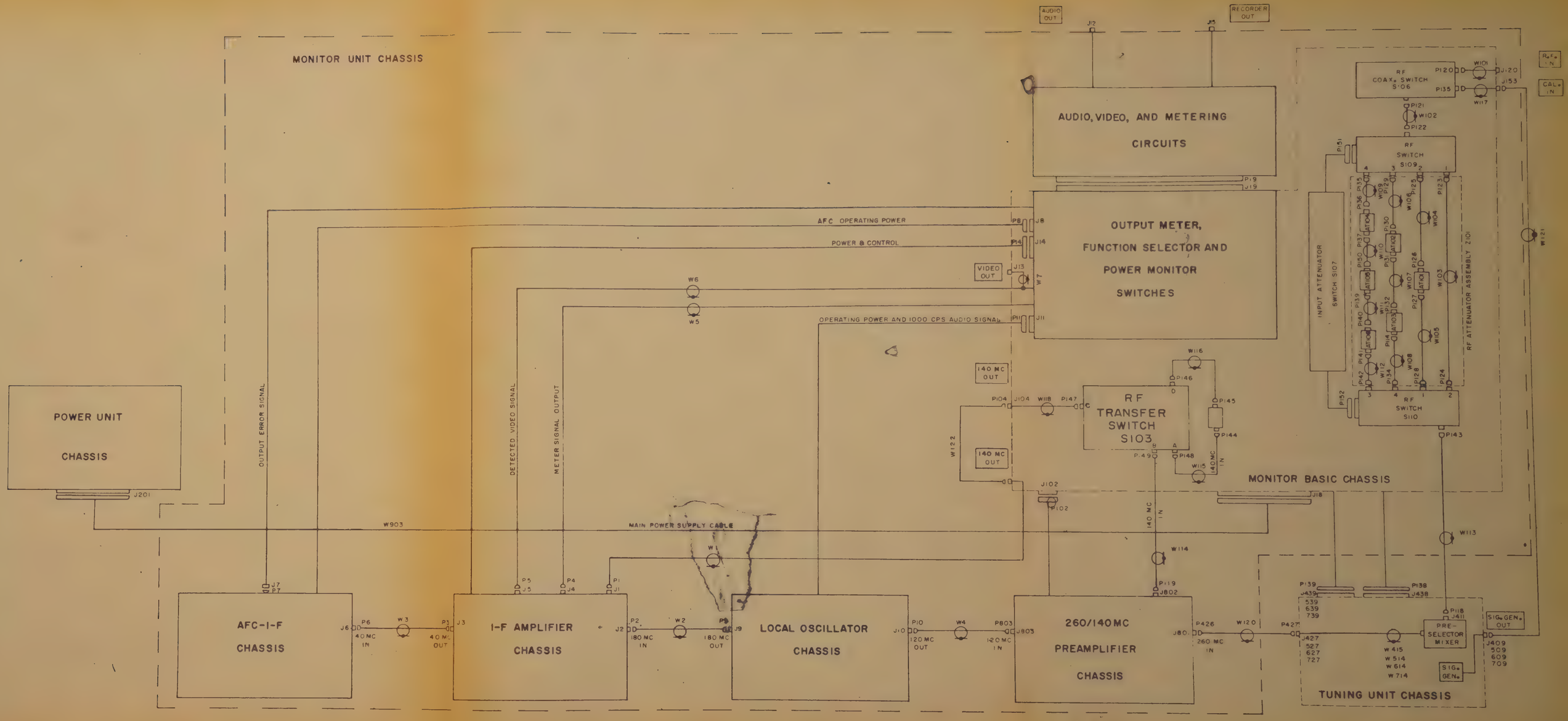


FIGURE 37. MICROWAVE FIELD INTENSITY METER, MODEL F1M,

TABLE XIII. TUNING UNIT FREQUENCY RANGES AND OSCILLATOR DATA

Characteristic	Band 1	Band 2	Band 3	Band 4
Receiver Tuning Range (in kmc)	1.000-2.240	2.140-4.340	4.200-7.740	7.360-10.000
Klystron Local Oscillator Frequency Range (in kmc)	1.260-2.500	2.400-4.600	4.460-8.000	7.000-9.740
Klystron Local Oscillator Cavity Mode (in wavelength)	1/4	3/4	3/4	3/4
Repeller Mode Switching	Required	Not Required	Not Required	Required
Repeller Mode (in cycles)	a. 1-3/4 cycles for frequencies below 1.300 kmc b. 2-3/4 cycles for frequencies above 1.300 kmc	2-3/4 cycles throughout tuning range	2-3/4 cycles throughout tuning range	a. 3-3/4 cycles for frequencies below 9.050 kmc b. 4-3/4 cycles for frequencies above 9.050 kmc
Klystron Tube Type	5837 (V401); 5837 or 6BM6 (V402)	5836 (V501); 5836 or 6BL6 (V502)	5721 or 6390 (V601 and V602)	5721 or 6390 (V701 and V702)
Klystron Beam Voltage	-325	-325	-1000	-1250
Klystron Beam Current (in ma.)	20 to 28*	20 to 28*	20	20
Klystron Grid Voltage	+10 0***	+10 0***	+10 approx**	+10 approx**

*Grid voltage set to +10 volts.
**Grid voltage adjusted for 20 ma. beam current.
*** 6BM6 and 6BL6 have zero voltage grid bias.

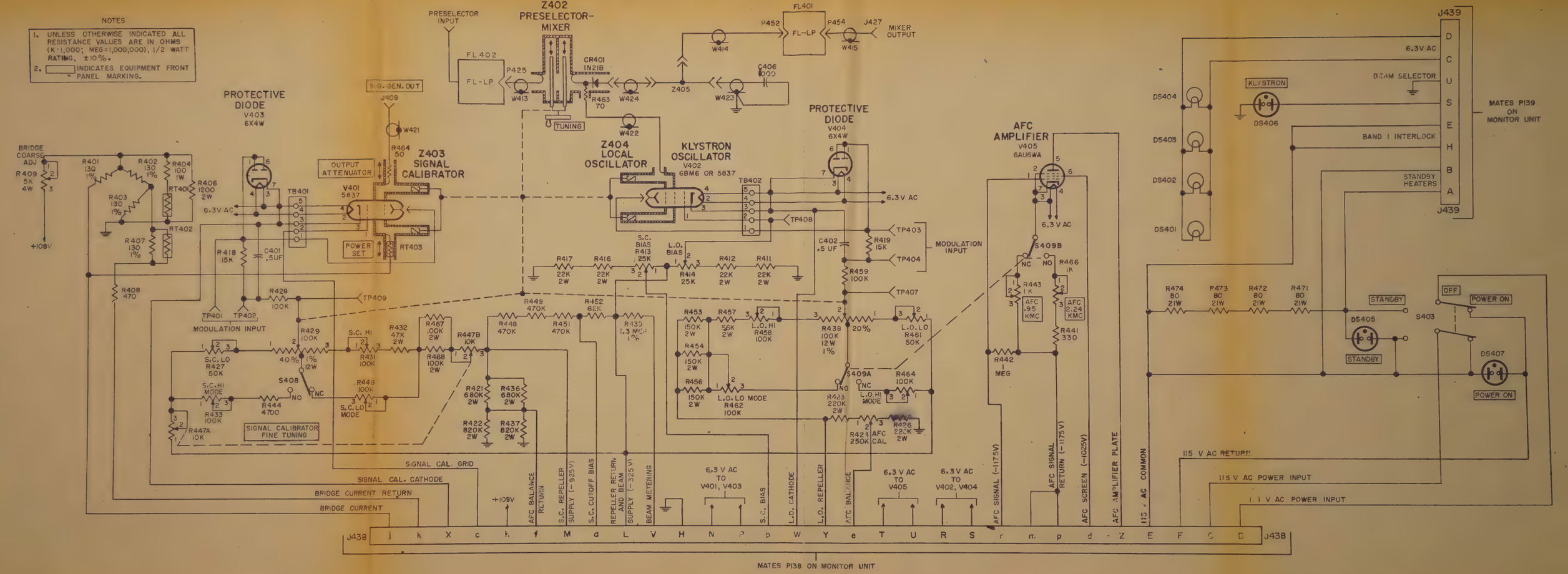


FIGURE 38. BAND I TUNING UNIT, MODEL FIM-L, SCHEMATIC DIAGRAM

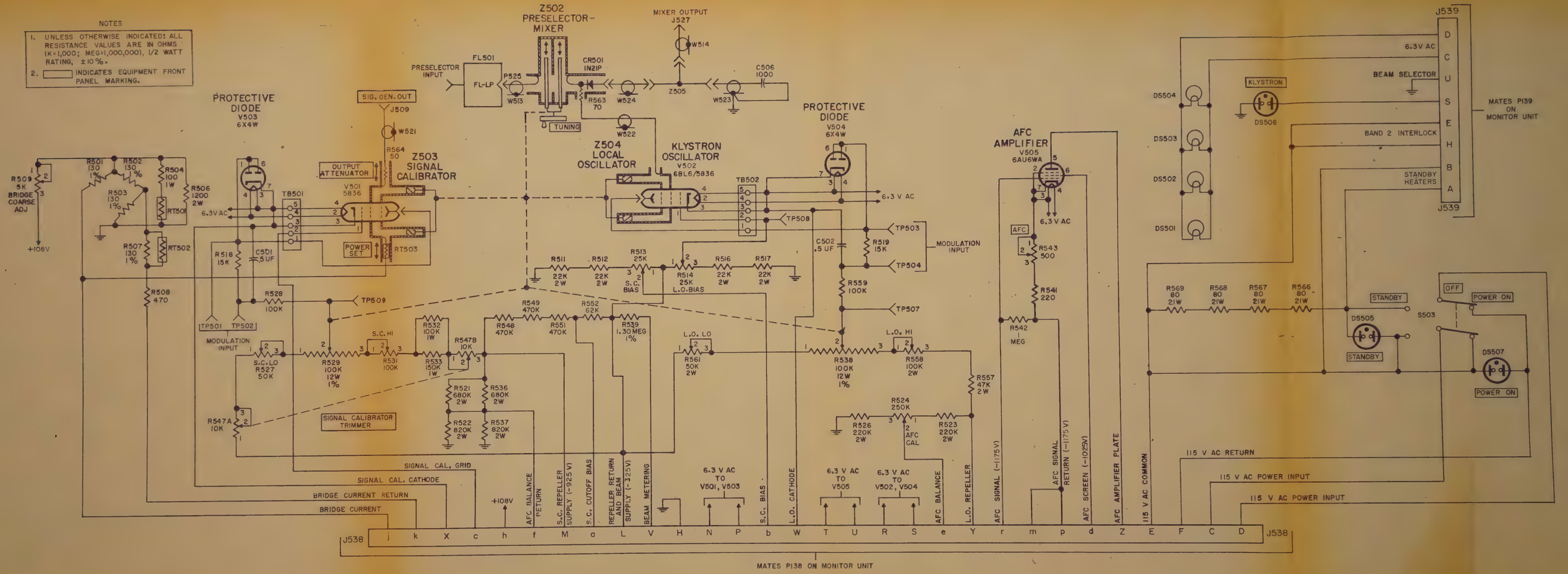


FIGURE 39. BAND 2 TUNING UNIT, MODEL FIM-S, SCHEMATIC DIAGRAM

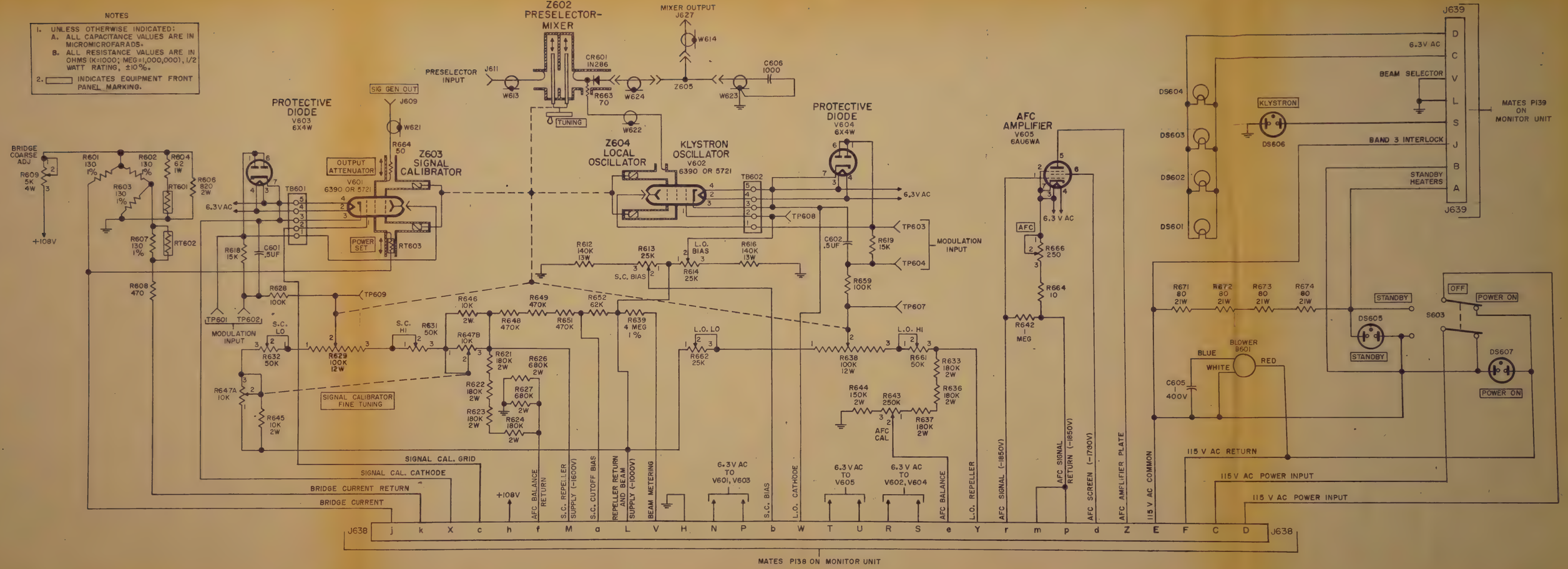


FIGURE 40. BAND 3 TUNING UNIT, MODEL FIM-M, SCHEMATIC DIAGRAM

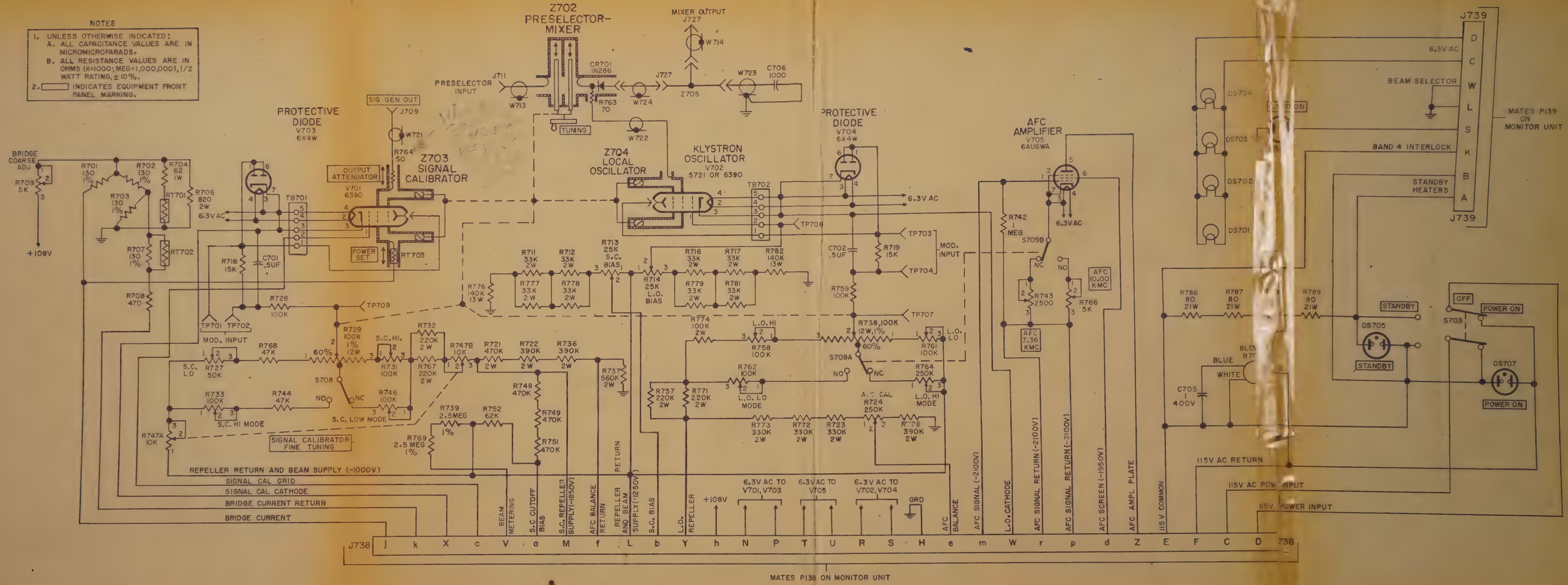


FIGURE 41. BA[illegible] TUNING UNIT, MODEL FIM-X SCHEMATIC DIAGRAM

28. LOCAL OSCILLATOR, DESCRIPTION (see Figure 38). Band 1 is taken as a typical Tuning Unit in the following description:

a. GENERAL - - The local oscillator uses a reflex klystron tube seated within a coaxial-cavity resonator. The oscillator tunes continuously over the range from 1.260 kmc to 2.500 kmc. The resonator is tuned by means of a non-contacting short-circuiting plunger. The reflector voltage applied to the klystron tube is tracked with the movement of the plunger through a mechanical drive system and a tracking potentiometer (R438). Power is extracted from the resonator, by loop coupling, at a fixed point in the cavity. This power is delivered to the first crystal mixer (CR401) where it is mixed with the output from the preselector (Z402).

b. REFLEX KLYSTRON - - The local oscillator tube V402 is a klystron with an external resonator. The resonant cavity connects to two electrodes termed "resonator grids". The resonator grids of the tube are separated from the cathode by an accelerator grid, which speeds up the electrons drawn from the cathode. The repeller electrode, on the opposite end of the tube from the cathode, operates at a high negative potential so that it can repel the electron stream. The cathode of tube V402 is fixed at -325 volts, while the repeller voltage varies with frequency.

c. KLYSTRON CAVITY - - The cavity employed is in the form of a coaxial transmission line, and consists of two cylinders, one inside the other. The klystron tube is inserted at one end of this line, so that the outer cylinder makes contact with the first interaction grid (so termed because it is closer to the cathode), while the inner cylinder makes contact with the second interaction

grid. At the other end, the circuit is completed by a movable non-contacting shorting plunger of special construction. The position of this movable short determines the resonant frequency of the cavity.

d. REPELLER VOLTAGE TRACKING - - The frequency of operation of the klystron oscillator is determined by the resonant frequency of the external cavity and by the magnitude of repeller voltage. For a given setting of the cavity, there is an optimum value of repeller voltage to produce the largest amount of rf power. Therefore, the repeller voltage must vary as the oscillator is tuned over its frequency range. In the Band 1 Tuning Unit, a mode switching arrangement is used to vary the d-c voltage on the repeller so that the potential applied to this repeller electrode is the proper value to produce the maximum amplitude of oscillation. The local oscillator frequency for the Band 1 tuning unit is 260 mc above dial frequency. The 1-3/4 repeller mode is used over the oscillator tuning range from 1.260 kmc to 1.560 kmc. At 1.560 kmc, it becomes advantageous to switch to the 2-3/4 repeller mode as a means of obtaining a stable rf signal. This switching is done, without changing the frequency of oscillation at a particular cavity setting, but by reducing the repeller voltage. After this reduction in potential, the klystron tube tracks throughout the remainder of its tuning range (1.560 to 2.500 kmc) in the desired 2-3/4 mode, as described below:

(1) The arm of the repeller voltage potentiometer (R438) is mechanically ganged to the oscillator tuning plunger and frequency dial. Mode switch S409A is operated by a cam on the drive

mechanism. This cam, after actuating mode switch S409A at a dial frequency of 1.560 kmc, changes the voltage applied to the tracking potentiometer as the TUNING control is rotated. Values of resistors in the tracking circuit (R453 through R464) are selected to ensure that the proper frequency-versus-voltage characteristic is obtained. Potentiometers R458, R461, R462 and R464 are provided for proper voltage adjustments at various settings of the frequency dial.

29. SIGNAL CALIBRATOR, BAND 1, DETAILED DESCRIPTION. (See Figures 38 and 41).

a. GENERAL - - The signal calibrator (V401) is a reflex klystron tube seated within a coaxial cavity resonator. The signal calibrator tunes continuously over the frequency range from 1.0 kmc to 2.240 kmc, as indicated on the engraved tuning drum. The reflector voltage applied to the klystron tube is tracked with the movement of the plunger through a mechanical drive system and a tracking potentiometer (R420). The signal calibrator generates a signal which is used to calibrate the gain of the receiver. It will function only when the "Function Selector" switch S105 is rotated in the CAL. SIG. GEN. position. In all other positions of this switch, the control grid, pin 1 of V401, is biased with a negative voltage preventing V401 to conduct.

Power is extracted from the coaxial cavity resonator through two separate means, both of which are variable by front panel controls. These are as follows:

(1) The OUTPUT ATTENUATOR control mechanically drives the rf output attenuator and dial to control the rf power level. Rotation of this control changes the position of the pickup loop at the

output of the klystron signal calibrator cavity. By this means, the output level of the signal calibrator can be accurately set.

(2) The setting of the front panel SIGNAL CALIBRATOR POWER SET control varies the position of thermistor RT403 within the power set pipe on the signal calibrator cavity, which determines the amount of rf current flowing through the power monitor bridge. The power monitor bridge circuit consists (Band 1 Tuning Unit) of resistors R401 through R409, thermistors RT402 and RT403, and (in the Monitor Unit) power monitor METER M1. When the meter pointer deflects to the CAL. position by adjustment of this control, the power level of the signal (taken at the SIG.GEN. OUT. jack) can be read directly from the calibrated ATTENUATOR dial.

The SIGNAL CALIBRATOR COARSE TUNING control mechanically adjusts the depth of the plungers within the cavity. Rotating this control will change the frequency of the signal calibrator without affecting the local oscillator Z404 frequency.

b. SIGNAL CALIBRATOR REPELLER VOLTAGE TRACKING. The frequency of operation of the signal calibrator is determined by the resonant frequency of the external cavity and by the magnitude of repeller voltage. For a given setting of the cavity, there is an optimum value of repeller voltage to produce the largest amount of rf power. As in the case of the first local oscillator (V402 in the corresponding Band 1 Tuning Unit), a mode switching arrangement is used to vary the d-c voltage on the repeller so that the potential applied to this repeller electrode is the proper value to produce the maximum amplitude of oscillation. A detailed circuit description follows:

(1) The arm of the repeller voltage potentiometer (R429) is mechanically ganged to the signal calibrator tuning plunger. Mode Switch S408 is operated by the cam on the drive mechanism. This cam changes the range of voltage applied to the repeller electrode at a particular point in the rotation of the TUNING control. Values of resistors in the tracking circuit (R427, R431, R443, R444, R446, R447, R467, and R468) are selected to ensure that the proper frequency-versus-voltage characteristic is obtained. Potentiometers R427, R431, R433 and R446 are provided for proper voltage adjustments at various settings of the frequency dial.

(2) The SIGNAL CALIBRATOR FINE TUNING control consists of two ganged potentiometers (R447A and R447B). Rotating this control will vary the reflector voltage to the klystron.

30. PRESELECTOR, DETAILED DESCRIPTION.

a. GENERAL - - The preselector in each Tuning Unit tracks with both the klystron local oscillator and with the signal calibrator over the frequency range. Two different types of preselectors are used in the various Tuning Units. All preselectors are variable-tuned, two-cavity types. When the preselector is tuned to the resonant frequency of either the applied rf signal or the output of the signal calibrator (determined by the position of the FUNCTION selector), the preselector passes this signal to the crystal mixer. The cavities operate as 1/4 or 3/4 wavelength resonant lines, and are tuned to the desired electrical length by rotation of the front panel TUNING knob on each Tuning Unit.

b. MECHANICAL DRIVE SYSTEM - - The mechanical drive system for each preselector is described below:

(1) The cam for the preselector drive is mounted to the main drive shaft. It converts rotation of the main tuning shaft to the translating motion required by the preselector. This cam drives a preselector follower, which causes the shaft and yoke of the preselector to move. The two movable plungers, which determine the electrical resonance of the preselector cavities, are mounted to the yoke.

(2) In addition to the direct drive system described above, a means of obtaining a small amount of correction to the motion of the plungers is provided for Bands 3 and 4 only. A correcting gear, which mates with a correcting rack, is mounted to the drive shaft. This gear and rack assembly causes two channels to move in synchronism with the main drive shaft. Each channel contains a tape cam, the shape of which may be adjusted by means of a series of screws. A correcting mechanism is provided for each tape cam, which pushes against one of the preselector plungers. Therefore, each preselector plunger can be corrected independently. In this way, precise insertion of each plunger within its preselector cavity is obtained at all points within the tuning range.

(3) In Bands 1 and 2, a series of adjustment screws are located at the top of the preselector cavity. The preselector can be accurately aligned by adjustment of these screws.

31. PROTECTIVE DIODE, DESCRIPTION.

Protective diode V403 is connected between the cathode and the repeller electrode of the klystron oscillator. This diode prevents the repeller of the klystron from going positive with respect to its cathode. Reference to the schematic diagram (figure 38) shows that the cathode, pin 7, of the diode is connected directly to the cathode of the reflex klystron, to which the -325 volt potential is applied. Since the plates, pins 1 and 6, of the diode are directly connected to the repeller electrode of the klystron, any circuit disturbance causing the diode plates (or the repeller electrode) to become more positive than -325 volts will drive tube V403 into conduction. When diode V403 is in a conducting state, the maximum positive repeller voltage is the small drop across the diode. In this manner, the repeller electrode of tube V403 is maintained at a minimum absolute potential of -325 volts, despite any factor that might drive the klystron repeller more positive than its cathode.

32. CRYSTAL MIXER, DESCRIPTION.

a. When the preselector is tuned to the frequency of either the applied rf signal or the frequency of the signal calibrator, the signal is passed through the preselector and is applied to the first crystal mixer. Simultaneously, rf energy from the local oscillator is applied to this crystal. The frequency of the klystron oscillator output will always differ from the rf signal frequency by 260 mc.

NOTE

In Bands 1, 2, and 3, the klystron oscillator is always tracked 260 mc higher than the applied rf signal. The klystron oscillator is tracked 260 mc lower than the applied rf signal in Band 4.

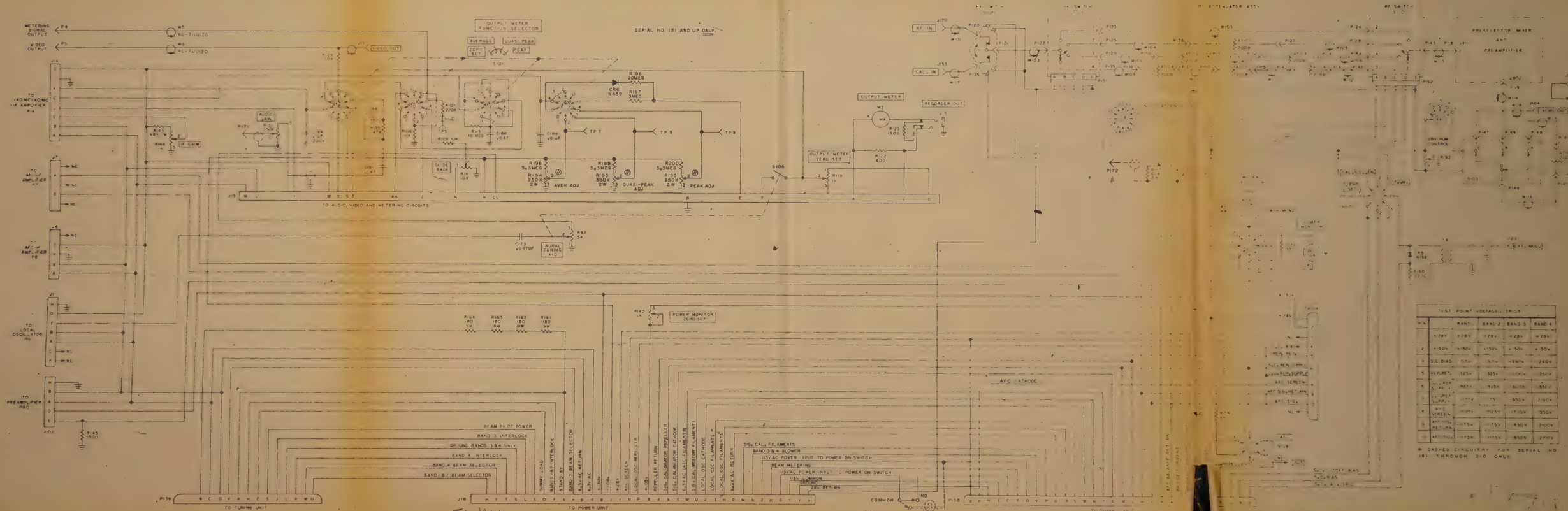
b. As an example of crystal mixer operation, assume Band 1 Tuning Unit is in use, and that the "Function Selector" is in the F.I.M. position. When the preselector is tuned to receive an incoming rf signal of 1.00 kmc, the klystron oscillator, which tracks with the preselector through the mechanical drive system, is tuned to 1.260 kmc. Due to the crystal mixer's non-linear characteristics, a beat frequency of 260 mc (the difference between the signal and local oscillator frequencies) is produced. This 260 mc difference signal is applied to a preamplifier, which is fixed-tuned to 260 mc.

33. DETAILED THEORY OF OPERATION, MONITOR UNIT.

INTRODUCTION - - The Monitor Unit is the control and metering unit of the FIM. A detailed description of the individual circuitries within the Monitor Unit are described in the following paragraphs.

34. RF COAXIAL SWITCH, DETAILED DESCRIPTION. (See Figure 42.)

a. An electrically operated rf coaxial switch is provided at the input to the receiver. Operation of this switch is dependent on the setting of the "Function Selector", as described below:



TEST POINT VOLTAGES (PRIOR TO 181)

PIN	BAND 1	BAND 2	BAND 3	BAND 4
	+28V	+28V	+28V	+28V
2	+30V	+30V	+30V	+30V
4	S.C. BIAS	-1.5V	-1.5V	-99V to -240V
5	REPELLER	325V	325V	750V
6	SIG. CAL. CATHODE	925V	925V	850V
7	LOCAL OSC. CATHODE	+175V	175V	850V
8	AFC SCREEN	+925V	+925V	+710V
9	AFC SIG. REF. PDET.	+175V	175V	850V
10	AFC BIAS	+175V	+175V	850V

* DASHED CIRCUITRY FOR SERIAL NO 181 THROUGH 210 ONLY.

FIGURE 42. MONITOR BASIC CHASSIS, SCHEMATIC DIAGRAM

(1) In the F.I.M. position of the "Function Selector" S105, plus 28 volts dc from the Power Unit is applied through the contacts of switch S105 to the No. 1 plus terminal of rf coaxial switch S106. The minus terminals of switch S106 are permanently connected to -28 volts dc. With 28 volts dc applied across the switch terminals, contact 1 of switch S106 makes continuity with the rf input signal applied by coaxial connector P120. The rf input signal is then coupled through turret switch S109 to rf attenuator assembly Z101.

(2) In the CALIBRATE position of the "Function Selector", plus 28 volts dc is removed from the No. 1 terminals of coaxial switch S106 by the contacts of switch S105. The 28 volts dc potential is then switched to the No. 2 terminals of coaxial switch S101 and causes contact No. 1 of S101 to break continuity with coaxial connector P120, and to make continuity with coaxial connector P135. Under this condition, the output of the signal calibrator V401 is coupled through the output attenuator and turret switch S109, to rf attenuator assembly Z101. The signal that may be coupled to the RF IN jack is now open-circuited at the input to the rf coaxial switch and is not applied to the circuitry of the FIM.

(3) In the ZERO SET position of the "Function Selector", plus 28 volts dc is disconnected from both terminals No. 1 and No. 2 of rf coaxial switch S106. Under this condition, neither the signal present at the RF IN jack J120 nor the output of the signal calibrator can be applied to the remainder of the circuitry. The ZERO SET position of S106 is used when zero-setting the OUTPUT METER.

35. RF ATTENUATOR ASSEMBLY, DESCRIPTION.

a. The built-in-step attenuator provides the following step ratios: 1, 10, 100, 1,000, and 10,000. Part of the attenuation is obtained in the input to the preselector-mixer circuit; the remaining part of the attenuator is obtained in the input to the 260 mc i-f amplifier. The attenuation steps are listed in Table XIV.

TABLE XIV. INPUT ATTENUATOR SETTINGS

Panel Setting (on Monitor Unit)	Rf Attenuation (in db)	260 Mc I-f Attenuation (in db)
0 db x1	0	0
20 db x10	0	20
40 db x100	20	20
60 db x1000	40	20
80 db x10,000	60	20

b. The rf attenuator is connected to an electrically-operated switching circuit which connects the desired amount of attenuation in the path of the rf signal, as determined by the setting of the front panel INPUT ATTENUATOR selector. Plus 28 volts dc is applied from the Power Unit to wafers B and C of INPUT ATTENUATOR switch S107.

(1) In position "0 db x1", no attenuation is switched into the signal path. The signal from terminal 1 of rf switch S109 is then coupled through cable W103 to terminal 2 of rf switch S110, and then to the input of the preselector-mixer. Reference should be made at this time to the representation of rf transfer switch S103. Switch S103 is shown in its deenergized position; therefore

the output of the preamplifier is coupled through the contacts of rf transfer switch S103, with no attenuation, for application to the i-f amplifier.

(2) In position "20 db x10", rf transfer switch S103 becomes energized, while rf switches S109 and S110 remain in the same condition as described in subparagraph (1) above. Therefore, the rf signal is again applied through cable W103 of Z101 (with no attenuation) to the preselector. However, the signal at the output of the preamplifier is now coupled through contacts B and A of rf transfer switch S103, and is attenuated 20 db by fixed attenuator AT107. This attenuated signal is then applied through contacts D and C of rf transfer switch S103 to the i-f amplifier circuitry.

(3) In position "40 db x100", rf switches S109 and S110 become energized. The rf signal is then attenuated 20 db by fixed attenuator AT401 before the signal arrives at the preselector. Since rf transfer switch S103 remains energized in the 40 db, 60 db, and 80 db positions of the INPUT ATTENUATOR selector, it is only necessary to keep in mind that the output of the preamplifier will be attenuated 20 db in the remaining positions of the INPUT ATTENUATOR selector. The rf output from the preamplifier has, therefore, been attenuated a total of 40 db (due to the action of attenators AT101 and AT107) before the 140-mc signal is applied to the i-f amplifier circuitry.

(4) In position "60 db x1000", rf switches S109 and S110 become energized. The rf signal is then attenuated 40 db by fixed attenuator AT102 before the signal arrives at the preselector.

In addition, the output of the preamplifier is attenuated an additional 20 db by AT107. Therefore, the signal which is applied to the i-f amplifier has been attenuated a total of 60 db.

(5) In position "80 db x10,000", rf switches S109 and S110 become energized. The rf signal is then attenuated 60 db by fixed attenuators AT104 and AT105 before the signal arrives at the preselector. In addition, the output of the preamplifier is attenuated an additional 20 db by AT107. Therefore, the signal is applied to the i-f amplifier has been attenuated a total of 80 db.

36. PREAMPLIFIER, DESCRIPTION. (See figure 43.)

A two-stage preamplifier circuit is located within the Monitor Unit. The first two stages (V801 and V802) function as a cascade-tuned amplifier, to increase the magnitude of the 260 mc input signal from the first crystal mixer. A crystal detector (CR801) functions as a second mixer, receiving two signals. One signal consists of a 120 mc output derived from a crystal-controlled oscillator. As a result of beating the 260 mc preamplifier output with the 120 mc crystal-controlled oscillator output in the second mixer, a type 1N82A crystal diode, a difference frequency of 140 mc is available at the output of the second mixer for application to the i-f amplifier. The output of the preamplifier is applied to an electrically-operated rf transfer switch S103. This transfer switch is de-energized when the INPUT ATTENUATOR selector is rotated to the 0 DB x1 position. Under this condition, the output of the preamplifier is applied without attenuation to the i-f amplifier. Refer to paragraph 35b, for a detailed description of the rf transfer switch when the INPUT ATTENUATOR selector is rotated to any of its positions other than 0 db X1.

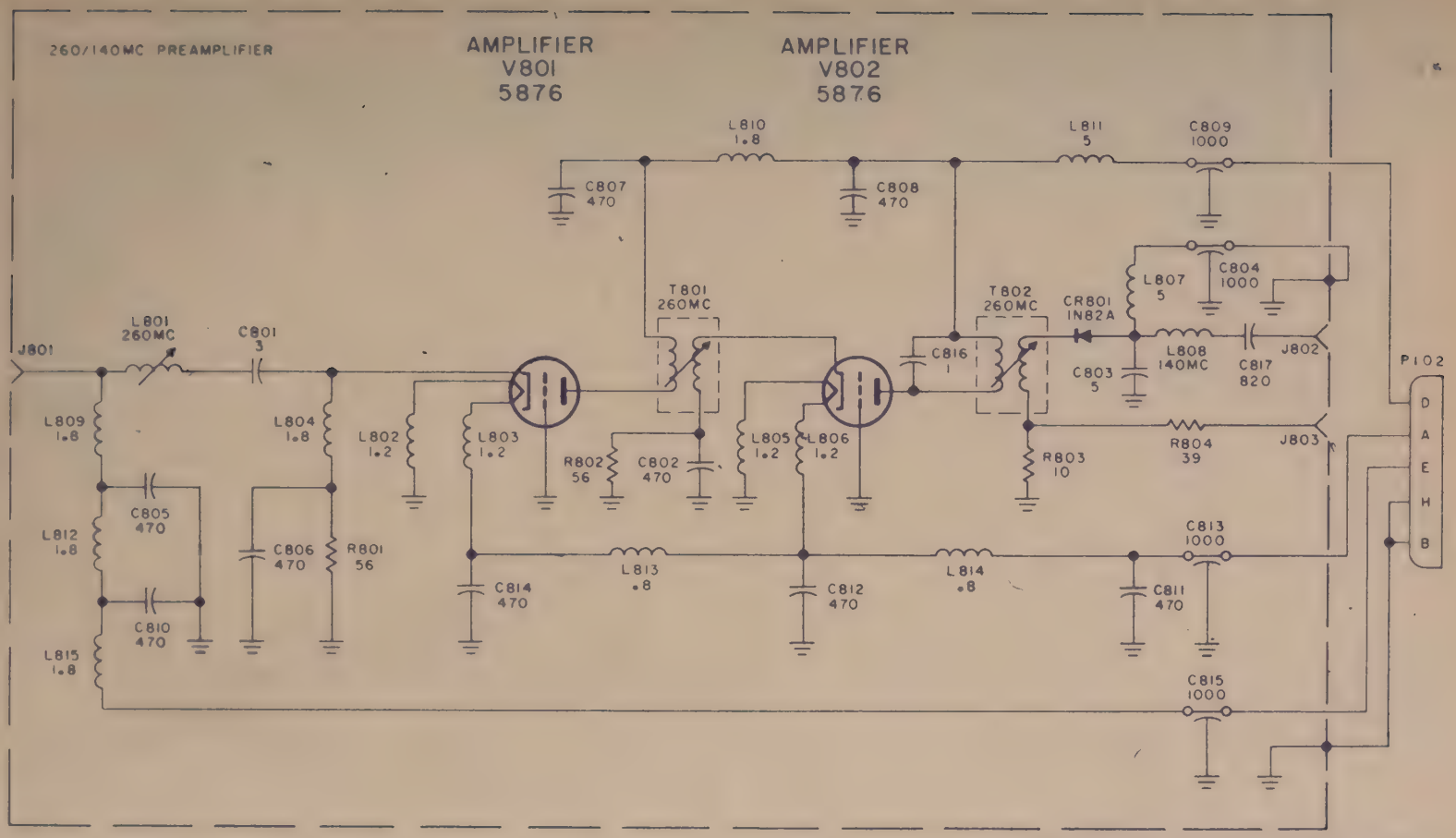


FIGURE 43. PREAMPLIFIER, SCHEMATIC DIAGRAM

37. I-F AMPLIFIER, DESCRIPTION . (See Figure 44.) The i-f amplifier consists of three stages of amplification at 140 mc, a mixer stage, three stages of amplification at 40 mc, a power amplifier, detector, and video cathode follower. The mixer stage functions to accept the 180-mc signal (which is derived from the crystal-controlled local oscillator) and mix this signal with the amplified 140-mc signal from the preamplifier. The resultant 40-mc difference frequency is then amplified in both voltage and power before being detected. The detected signal is applied to two circuits. One is the metering circuit; the other is the video amplifier circuit. The detected signal is also coupled, through a cathode follower, to a front panel VIDEO OUTjack, so that oscilloscope observation of the detected signal may be obtained, if desired.

38. CRYSTAL-CONTROLLED LOCAL OSCILLATOR, DESCRIPTION (See Figure 45.) The crystal-controlled local oscillator consists of four tubes. The first, V17, is an oscillator which operates at the fundamental crystal frequency of 30 mc. The second half of this tube functions as a doubler. This doubled signal (60 mc) is amplified by V18 and is applied to both a doubler, V20, and a tripler, V19. The output of doubler V20, at a frequency of 120 mc, is used to heterodyne with the 260-mc signal in the preamplifier. As a result, a frequency conversion to 140 mc occurs, and is present at the output of the preamplifier. The output of the tripler, V19, is used to heterodyne with the 140-mc signal at the input to the i-f amplifier. As a result, a frequency conversion to 40 mc occurs and is available for power amplification and signal detection as a final video output.

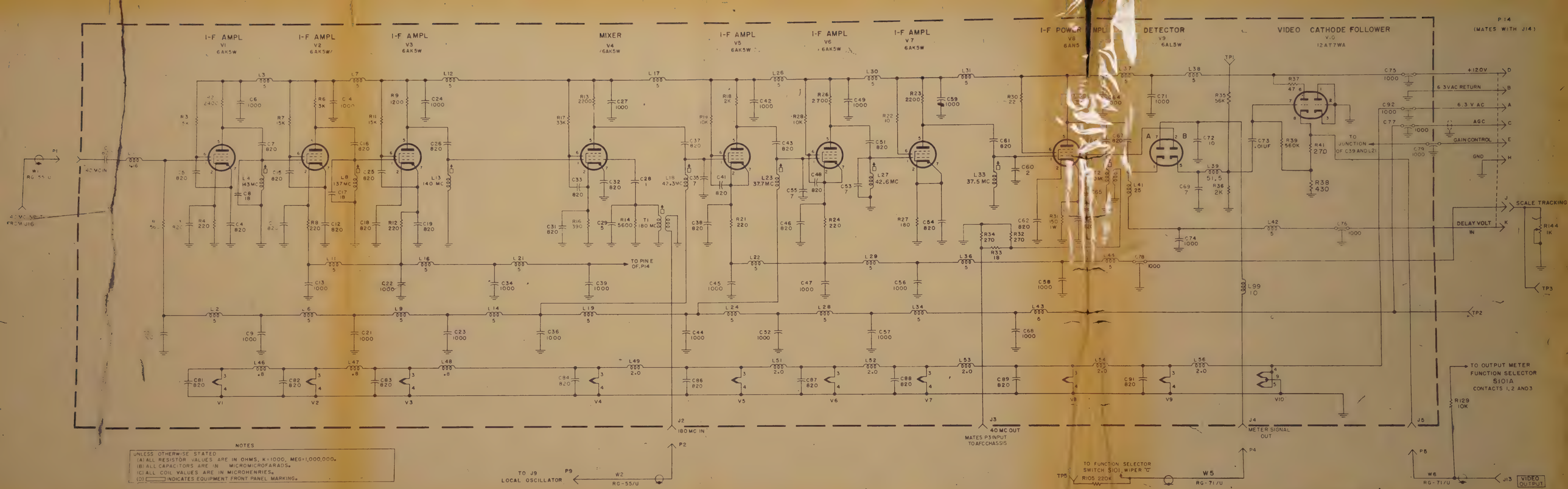

I-F AMPL V1 6AK5W
I-F AMPL V2 6AK5W
I-F AMPL V3 6AK5W
MIXER V4 6AK5W
I-F AMPL V5 6AK5W
I-F AMPL V6 6AK5W
I-F AMPL V7 6AK5W
I-F POWER AMPL V8 6AN5
DETECTOR V9 6AL5W
VIDEO CATHODE FOLLOWER V10 12AT7WA
P14 (MATES WITH J14)
+120V
6.3VAC RETURN
6.3 V AC
AGC
GAIN CONTROL
GND
SCALE TRACKING
DELAY VOLT IN
TO JUNCTION OF C59 AND L21
TO PIN E OF P14
40 MC IN FROM J16
J2 180 MC IN
J3 40 MC OUT MATES P3 INPUT TO AFC CHASSIS
J4 METER SIGNAL OUT
J5
TO OUTPUT METER FUNCTION SELECTOR S101A CONTACTS 1, 2 AND 3
TO J9 LOCAL OSCILLATOR
TO FUNCTION SELECTOR SWITCH S101, WIPER 'C'
W5 RG-71/U
W6 RG-71/U
J13 VIDEO OUTPUT
NOTES
UNLESS OTHERWISE STATED
(A) ALL RESISTOR VALUES ARE IN OHMS, K=1000, MEG=1,000,000.
(B) ALL CAPACITORS ARE IN MICROMICROFARADS.
(C) ALL COIL VALUES ARE IN MICROHENRIES.
(D) INDICATES EQUIPMENT FRONT PANEL MARKING.

FIGURE 44. 140MC/40MC IF AMPLIFIER, SCHEMATIC DIAGRAM

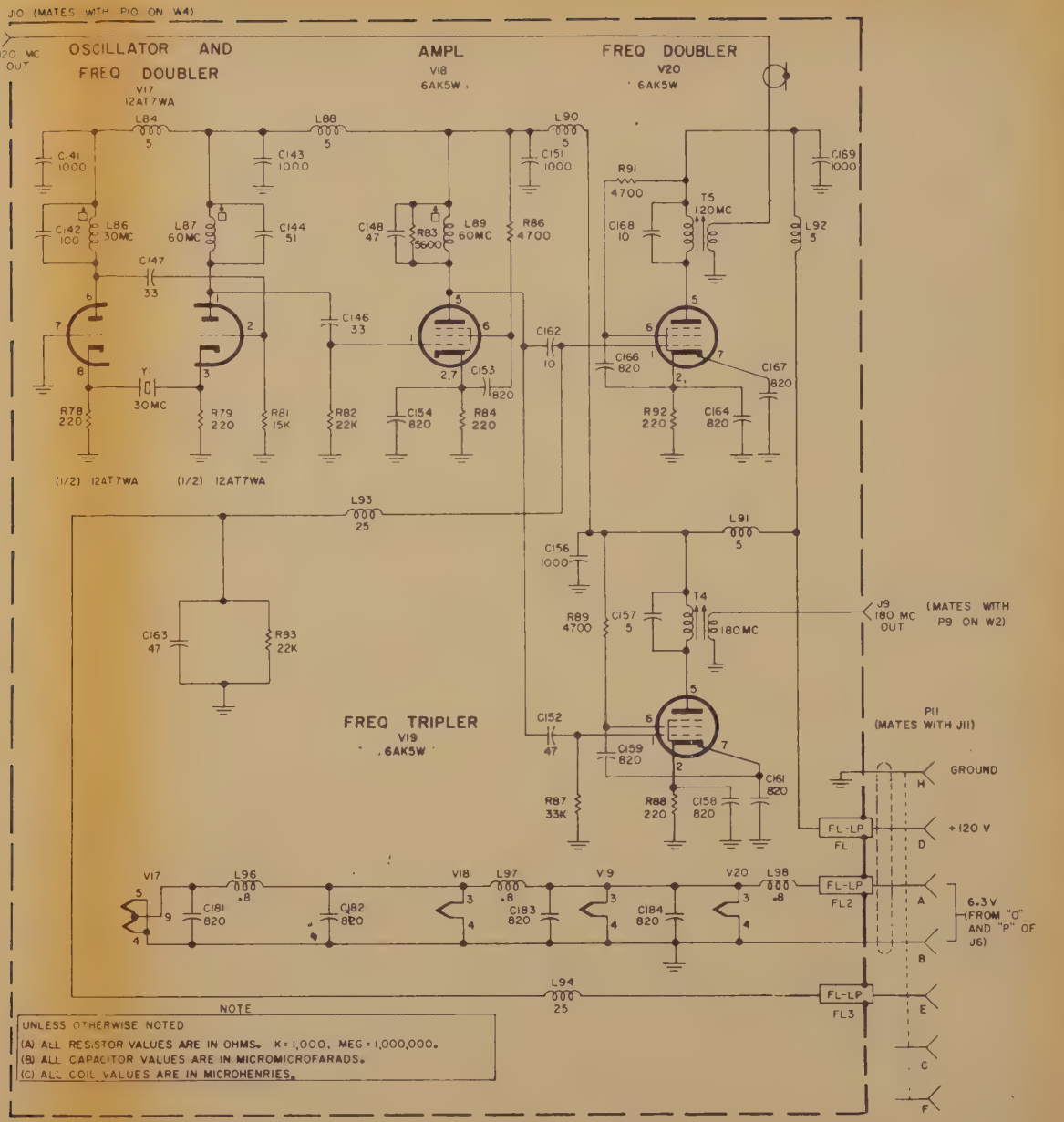


FIGURE 45. CRYSTAL CONTROLLED LOCAL OSCILLATOR, SCHEMATIC DIAGRAM.

39. AFC CHASSIS, DESCRIPTION. (See Figure 46.) This chassis consists of six tubes and two crystal diode discriminators. The first two stages, V11 and V12, are used to amplify the 40-mc signal which is present at the input to detector V9 (in the i-f amplifier). Limiters V13 and V14 clip the signal before applying power to driver stages V15 and V16. One driver, V15, operates at a frequency of 38.25 mc; the other driver, V16, operates at 41.75 mc. Each stage, V15 and V16, gives a maximum response to signals of the corresponding frequencies, and supplies power to discriminator diodes CR1 and CR2. When the signal frequency from limiter V14 is lower than 40 mc, the output of driver V15 is increased, and the dc output from diode CR2 is greater than that from diode CR1. When the signal frequency from limiter V14 is higher than 40 mc, the output of driver V16 is increased and the dc output from CR1 exceeds that from CR2. Operation at the 40-mc intermediate frequency causes an equal output in both drivers V15 and V16, therefore producing no difference in output from the two diodes. The output of the afc circuit is applied to the grid of an afc amplifier which is provided within each of the Tuning Units. When the AFC switch is rotated to the IN position, the output of the afc amplifier applies a correction voltage to the repeller tracking circuit of the klystron oscillator tube. By means of this method of "electronic tuning" of the klystron, the afc circuit compensates for any long period frequency drift in the incoming signal.

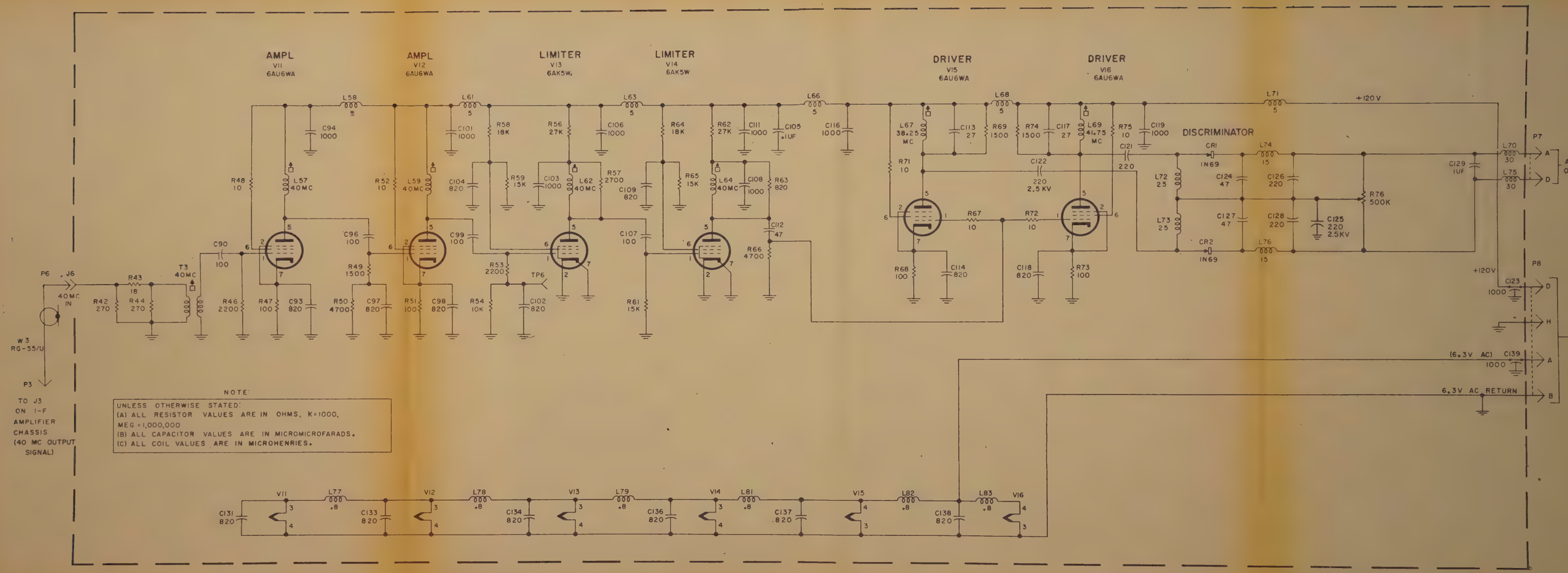


FIGURE 46. AFC-IF AMPLIFIER, SCHEMATIC DIAGRAM.

40. AUDIO, VIDEO, AND METERING CIRCUITS. The audio, video, and metering circuits consist of a six-tube chassis, which is mounted to the top frame of the Monitor Unit. (See figure 47.) These circuits are described in subparagraphs a, b, and c, below:

a. AURAL TUNING AID CIRCUIT. Audio oscillator V21 and power amplifier V22 are utilized to produce the 1,000-cps modulation note which applies a tone signal to the detected c-w signal, when the AURAL TUNING AID control is rotated clockwise beyond its "off" position. Under this condition, the 1,000-cps signal is coupled to the grid of doubler stage V20 (in the crystal-controlled local oscillator chassis). The 120-mc output of the doubler is then modulated at 1,000 cps before it is injected into the second crystal mixer (in the preamplifier). By this means, the final output of the preamplifier, which produces a beat signal of 140 mc, is modulated. After further amplification and frequency conversion within the i-f amplifier, the modulated intermediate frequency is detected by signal detector V9A (in the i-f amplifier) and is available as an audio signal when a pair of headphones is connected to the front panel AUDIO OUT jack J12.

b. AUDIO AMPLIFIER CIRCUIT. With Output Meter Function Selector switch S101 (figure 42) rotated in any position other than PEAK, the signal developed across load resistor R41 of video cathode follower V10 is coupled by the "A" section of switch S101 to AUDIO GAIN control R131. The setting of potentiometer R131 determines the amplitude of the signal applied to the grid of audio amplifier V25. This tube is self-biased, with its cathode resistor R137 unbypassed, to provide negative feedback. The feedback circuit aids in minimizing audio distortion. Output is coupled through capacitor C192 to power amplifier V26. This stage is a conventional

39.85

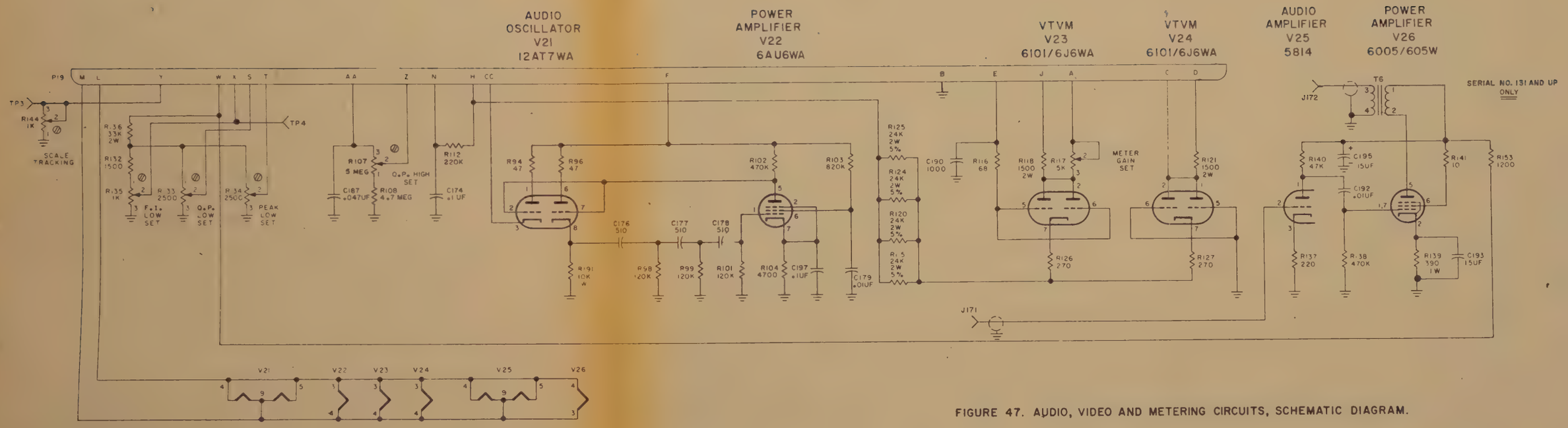


FIGURE 47. AUDIO, VIDEO AND METERING CIRCUITS, SCHEMATIC DIAGRAM.

power amplifier, utilizing output transformer T6 in its plate circuit. The secondary of transformer T6 provides an output impedance of approximately 600 ohms. The AUDIO OUT jack, is connected across the secondary winding of transformer T6, and permits monitoring of the audio output signal thrcugh a headset.

c. METERING CIRCUIT. The metering circuit consists of Output Meter Function Selectir switch S101, the proper "weighting circuits" for average, quasi-peak, and peak measurements, and the vacuum-tube voltmeter stages, V23 and V24. Paragraph 41 below, describes the metering circuit in detail.

41. FUNCTION SELECTOR AND WEIGHTING CIRCUITS. (See figures 48 through 51.)

NOTE

The term "weighting", as used in this handbook, refers to the time constant introduced in the detector and agc circuits. This "weighting" effectively determines the time-versus-voltage characteristics of the meter indication obtained on the OUTPUT METER on the Monitor Unit front panel.

a. GENERAL. The weighting circuits are selected by means of Output Meter Function Selector switch S101 and serve to weight the signal supplied to OUTPUT METER M2 properly for the three types of measurements performed by the equipment. These circuits, and the performance features for each of the positions of switch S101 are discussed in the following subparagraphs. Simplified schematic diagrams (figures 48 through 50) are employed to illustrate these circuits. In addition, a simplified schematic of the vacuum-tube voltmeter circuit is shown in figure 51.

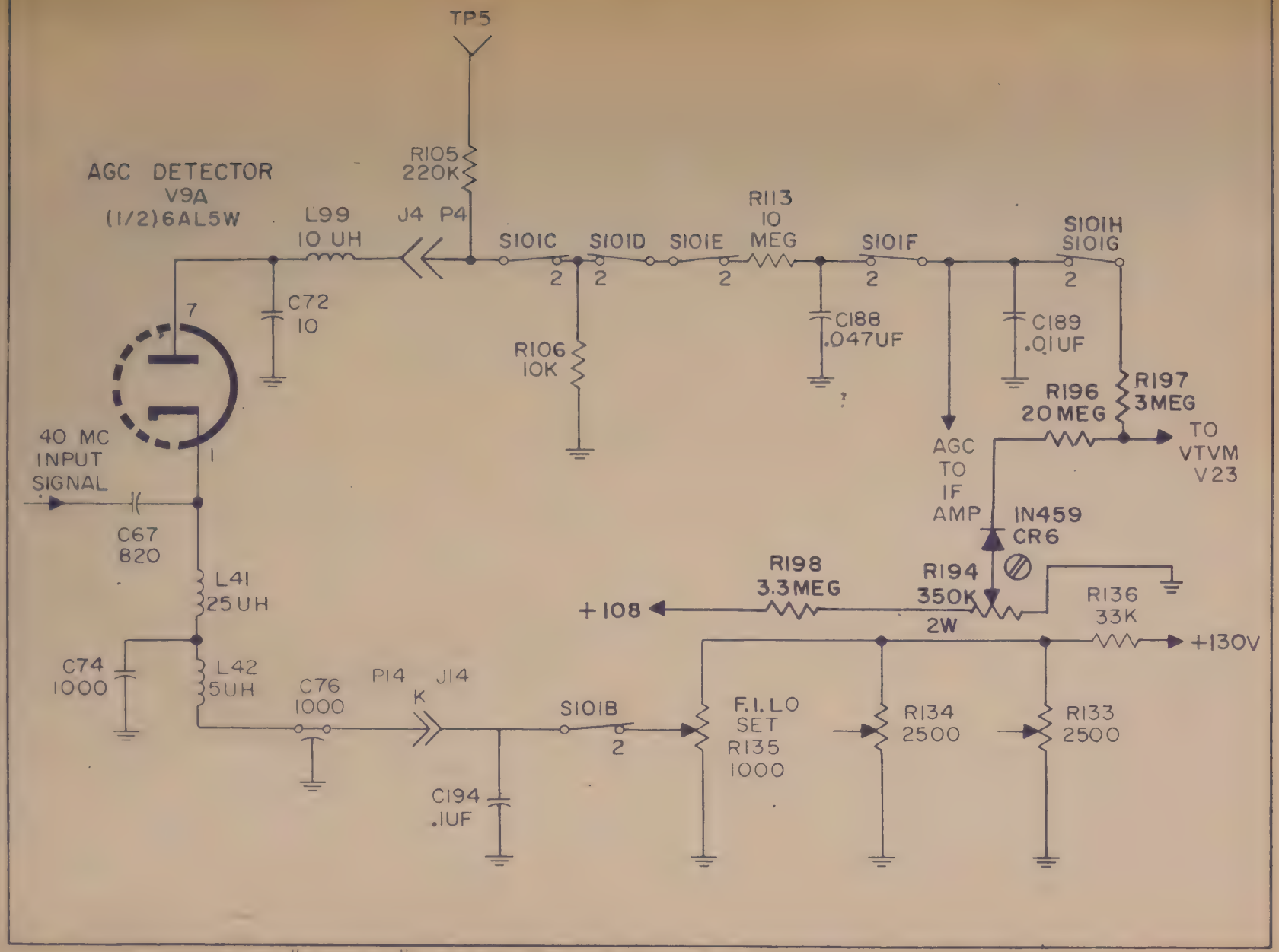


FIGURE 48. "AVERAGE" POSITION OF FUNCTION SELECTOR S101, SIMPLIFIED SCHEMATIC.

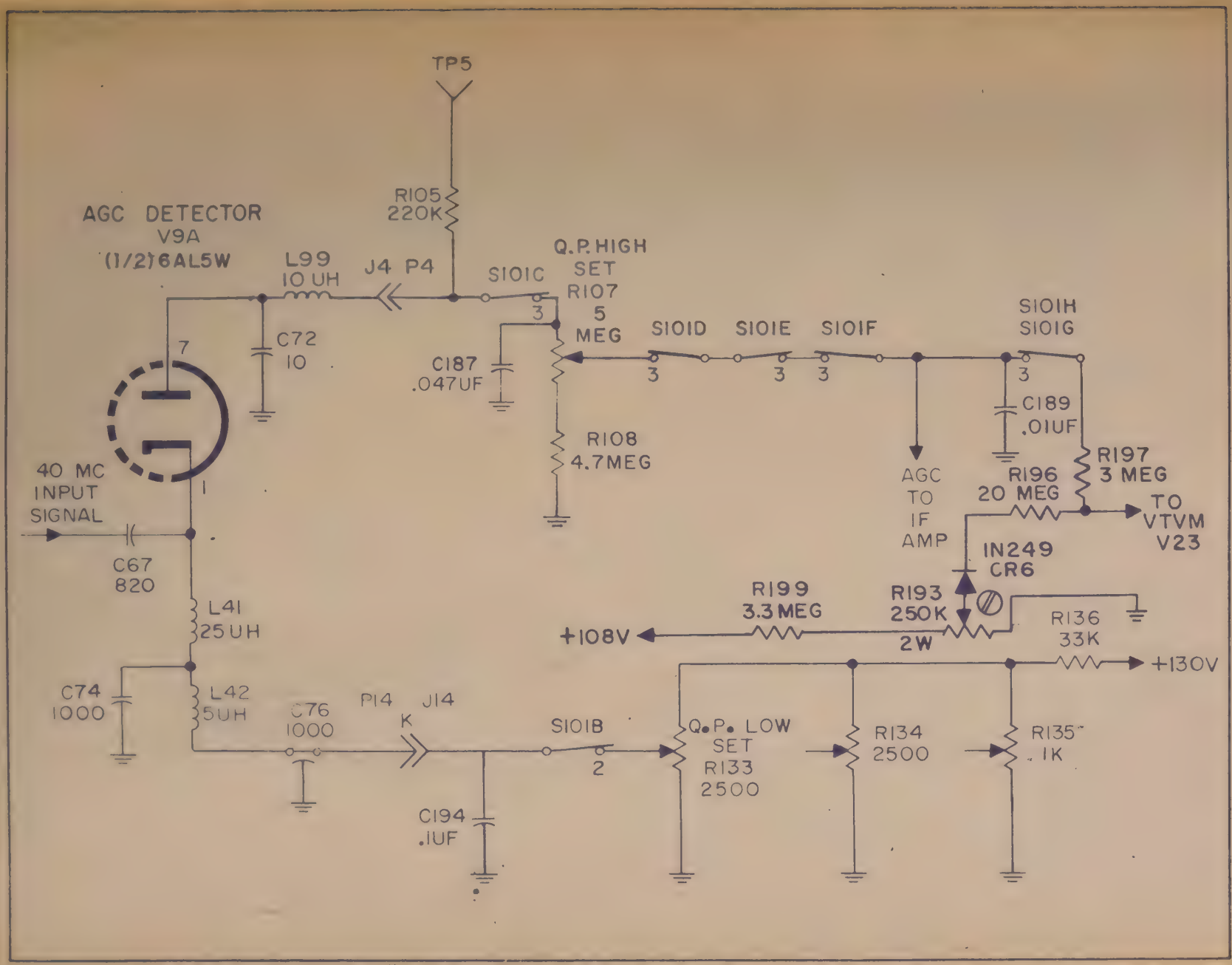


FIGURE 49. "QUASI-PEAK" POSITION OF FUNCTION SELECTOR S101, SIMPLIFIED SCHEMATIC.

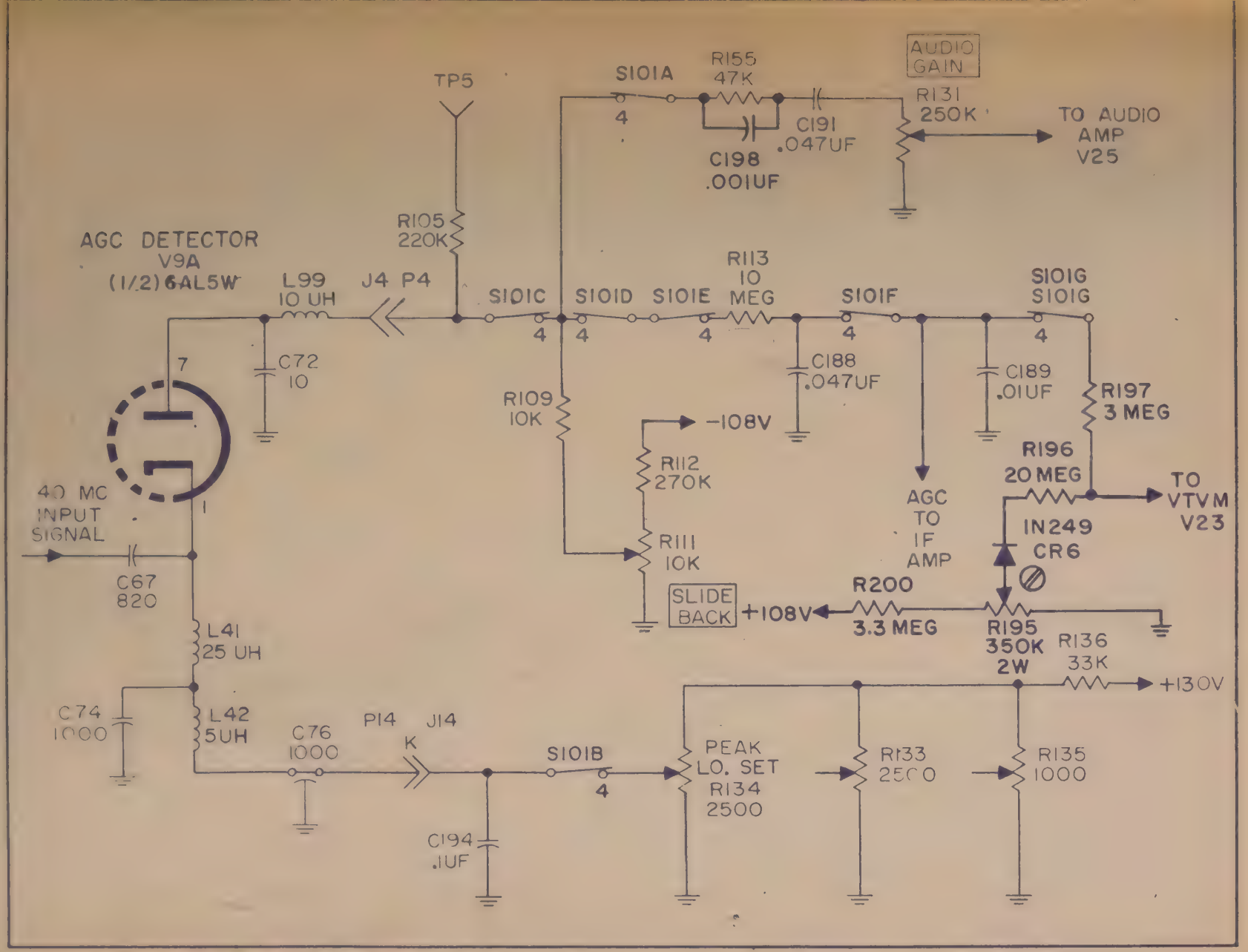


FIGURE 50. "PEAK" POSITION OF FUNCTION SELECTOR S101, SIMPLIFIED SCHEMATIC.

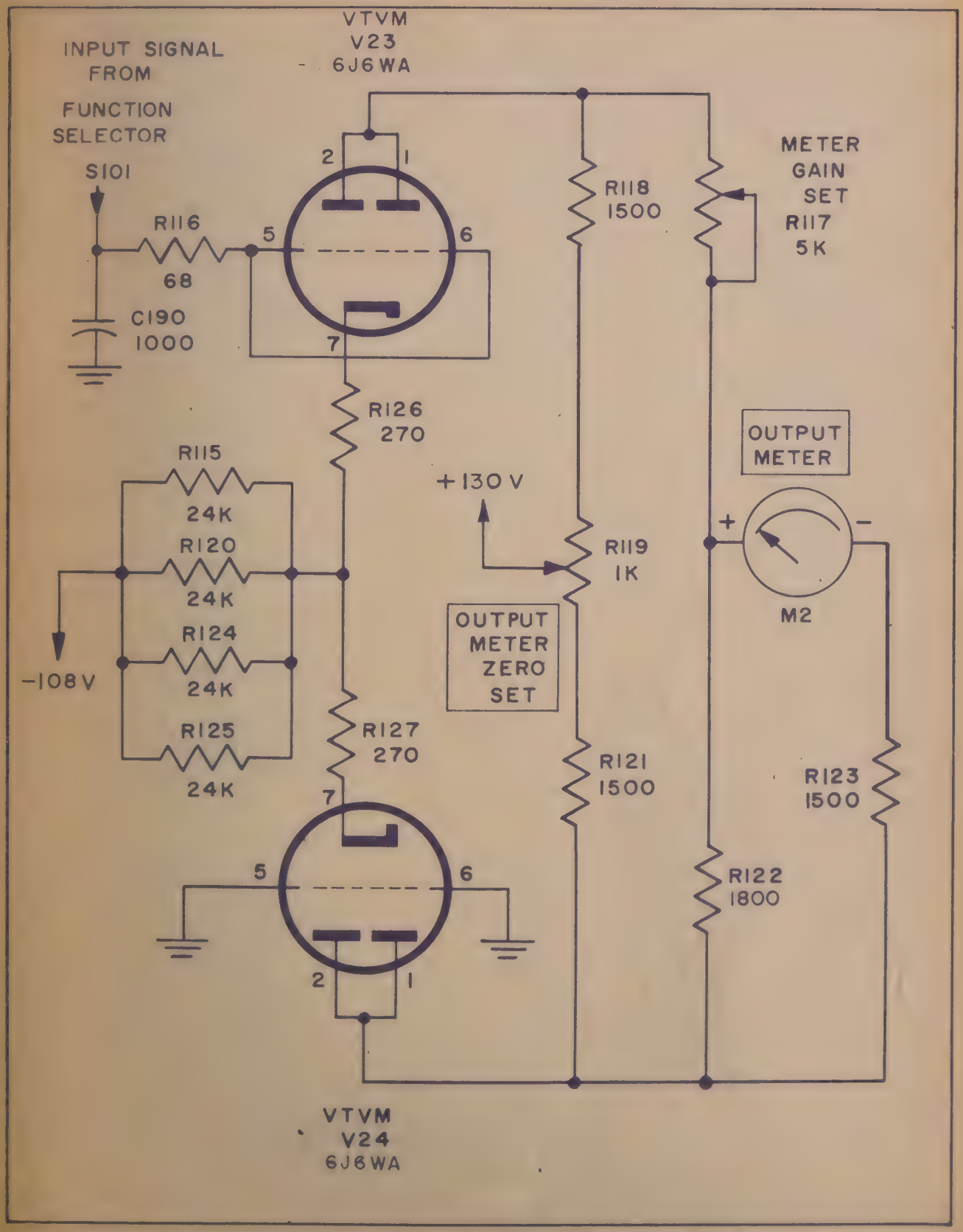


FIGURE 51 .VACUUM TUBE VOLTMETER CIRCUIT, SIMPLIFIED SCHEMATIC.

b. AVERAGE POSITION. (See figure 18.) In the AVERAGE position of Output Meter Function Selector switch S101, the metering signal is developed by only one half (pins 1 and 7) of detector V9. Resistor R136, which is connected to the detector plate (pin 7) by switch sections S101C and S101D, is the load resistor for the age detector. Choke coil L99 and bypass capacitor C72 constitute an i-f filter to prevent appearance of an i-f signal component in the video signal applied to the meter. A detailed circuit description follows:

(1) A small contact potential exists between the plate and cathode of detector V9A. If choke coil L42 were connected to ground and no signal was applied to the cathode, a small voltage would be developed across plate load resistor R136. This voltage would also appear in the vacuum-tube voltmeter circuit and would cause a small deflection on the OUTPUT METER. To counteract this developed voltage, a small positive potential (derived from the plus 130-volt supply, dropping resistor R136, and the parallel network of R133 through R135) is applied through switch section S101B, feed-through capacitor C176, and chokes L41-L42, to the cathode, pin 1, of detector V9A. The F.I. LOW SET control, R135, is adjusted to cancel the contact potential of V9A.

(2) The detector output is applied to the age circuit, R113 and C188, to produce the age signal which is applied through switch section S101F to the grids of the first 140-mc amplifier (V1) and the first and second 40-mc amplifiers (V5-V6) in the i-f amplifier chassis. The time constant of the age circuit (R113 and C188) has a relatively slow charge and discharge time, and functions to filter out most of the modulation present in the detector output. A d-c output produced has a magnitude which is proportional to the

average original carrier level. This same agc (average carrier level) signal is also applied, to an additional bypass capacitor C198) and through switches S101G and S101H, to a non-linear circuit which controls the VTVM response to the detected signal. This signal is then applied to the vacuum-tube voltmeter circuit to actuate the pointer of OUTPUT METER M2. (See figure 51.)

(3) Reference to the overall block diagram of the Monitor Unit (figure 36) shows that the second half of detector V9 (pins 2 and 5) is used as a signal detector. The video voltage developed across filter choke L39 and resistor R36 is applied to the grid of cathode follower V10. The output signal across load resistor R41 is coupled through coaxial connectors J5-P5 to cable W6. The signal is available at front panel VIDEO OUT jack J13 for connection to an external oscilloscope, if desired. A parallel signalpath is provided to contacts 1, 2, and 3 (ZERO SET, AVERAGE, and QUASI-PEAK positions) of switch section S101A. The wiper on this switch section couples the signal through AUDIO GAIN control R131 to the input of audio amplifier V25. After voltage amplification in V25, the signal is applied to power amplifier V26 and is available for audio monitoring at AUDIO OUT jack J12.

c. QUASI-PEAK POSITION. (See Figure 49.)

(1) In the QUASI-PEAK position of Output Meter Function Selector switch S101, the small contact potential between cathode and plate (pins 1 and 7) of detector V9B must be counteracted. This is accomplished by means of a similar circuit to that described in subparagraph b, above, for the AVERAGE position of S101. However, the

controlling potentiometer, in QUASI-PEAK position, is the Q.P. LOW ADJ potentiometer, R133. The control is adjusted to cancel the contact potential of V9A.

(2) Switch section S101C now connects the different load into detector V9B plate circuit. The series combination of Q.P. HIGH ADJ potentiometer R107 and fixed resistor R106, together with capacitor C187, constitute the weighting circuit. When detector V9B conducts, capacitor C187 charges up rapidly; when V9B ceases to conduct, capacitor C187 discharges slowly through series resistors R107-R106, resulting in a long discharge time. Therefore, in the case of a received signal containing pulses occurring in rapid succession, the average voltage appearing across resistors R107-R106 will be near the peak value of the pulses. This voltage appearing across R107-R106 is used as the agc (and quasi-peak value) signal which is applied through switch sections S101D, S101E, and S101F to stages V1, V5, and V6 in the i-f amplifier. The weighted signal voltage is coupled through switches section S101G and S101H, to a non-linear circuit which controls the VTVM response to the detected signal. It is then applied to the vacuum-tube voltmeter circuit to actuate the OUTPUT METER M2.

(3) As in AVERAGE position operation (see figure 48), video voltage developed across detector V9B, filter choke L33, and resistor R36 is applied to the grid of cathode follower V10. This signal is coupled, in parallel, to VIDEO OUT jack J13 and through Output Meter Function Selector switch S101A to the audio amplifier (V25) and power amplifier (V26) stages. The signal is available for audio monitoring at AUDIO OUT jack J12.

d. PEAK POSITION. (See figure 50.)

(1) In the PEAK position of Output Meter Function Selector switch S101, the peak values of pulse signals are to be measured. In this case, resistor R109 is the load resistor for diode V9A, while the audio output of signal detector V9B is disconnected from the circuit by switch section S101A. Reference to figure 50 shows that load resistor R109 is no longer connected to ground (as was the case for the load resistors in AVERAGE and QUASI-PEAK positions), but is connected through adjustable SLIDEBACK control R111 and fixed resistor R112 to a source of negative bias potential (minus 108 volts). This circuit arrangement provides the standard "slideback" measurement facility for the determination of peak values.

(2) Switch section S101B permits application of a positive bias from PEAK LOW SET potentiometer R134 to the cathode, pin 1, of detector V9A. This circuit arrangement permits equalizing the OUTPUT METER reading in the PEAK position with that obtained in the QUASI-PEAK position of switch S101.

(3) Switch sections S101E and S101F connect the age circuit, R113 and C108, to the grids of V1, V5, and V6 in the i-f amplifier. Switch section S101G applies the video signal to the vacuum-tube voltmeter. Since the aural slideback technique is used in the PEAK function of the equipment, the same signal voltage which is developed across load resistor R109 is coupled (through switch section S101C and AUDIO GAIN control R131) to audio amplifier V25. In operation, SLIDEBACK control R111 is first set to produce zero bias; the control is then rotated in the clockwise direction until the signal heard in the headphones sharply diminishes. At this point, the signals applied to detector V9A is just beginning to overcome the bias supplied by R111. For normal slideback procedures, the bias is increased to the point where cutoff occurs. This bias voltage, is then,

the measurement of the peak value of the signal and is effective at the plate (pin 7) of V9A, the agc bias circuit, and the input to the vacuum-tube voltmeter circuit. For this reason, the pointer deflection on OUTPUT METER M2 is the measurement of the signal peak values.

42. VACUUM-TUBE VOLTMETER CIRCUIT. (See figure 51.)

a. The vacuum-tube voltmeter is basically a difference amplifier consisting of two twin-triodes, V23 and V24. Each twin-triode has its half-sections connected in parallel. Balance between the two tubes in achieved through the use of OUTPUT METER ZERO SET control R119, connected across the two plates. The input to the vacuum-tube voltmeter is applied from agc detector V9B through Output Meter Function Selector switch S101 to the parallel-connected grids, pins 5 and 6, of tube V23.

b. The grids of tube V24 are grounded, but both tubes V23 and V24 have their cathode resistors tied to the same 100-volt negative bias potential through the parallel network consisting of resistors R115, R120, R124, and R125. The current flowing through the meter is dependent on the difference in d-c voltages applied to the control grids of V23 and V24. Therefore, differences in signal level at detector V9B cause a change in the current flowing through tube V24. As a result, the voltage at the V24 plate varies, and this difference voltage is applied across OUTPUT METER M2. Pointer deflections of the meter are proportional to the difference in d-c voltage output of tubes V23 and V24. In this manner, the vacuum-tube voltmeter produces an indication (properly weighted, depending on the weighting circuit switched into the circuit by the Output

meter Function Selector switch) which is proportional to the incoming signal level. This signal can be either the signal applied to the RF IN jack (with the "function selector" in F.I.M. position) or the output of the self-contained signal calibrator (with the "function selector" in CAL. SIG. GEN. position).

43. Detailed Theory of Operation, Power Unit (See figures 52 and 53.)

a. INTRODUCTION. A functional block diagram of the Power Unit is given [illegible] its schematic diagram is shown in figure 52. Essentially, the Power Unit includes three basic power supplies within its circuitry, as follows:

(1) The beam supply, comprising delay relays K201, K202, and stages V201 through V206.

(2) The repeller and afc power supply, comprising stages V208 through V214.

(3) The low voltage supply, comprising selenium rectifier CR201 and stages V217 through V224.

b. STANDBY POWER DISTRIBUTION. The POWER switch, S403, S503, S603 or S703 located on the appropriate Tuning Unit front panel, determines the distribution of power to the circuits within the receiver. The 115-volt line connected to Power Input jack J203, at the rear of the Power Unit is coupled through protective fuses F201, F202, and line filters FL201 and FL202. The filtered a-c power is supplied from J203 (rear of Power Unit) to the corresponding pins of J101, at the rear of the Monitor Unit. With the POWER switch in STANDBY position, power is applied to the following circuits: cathode heaters R161 through R164 (in the Monitor Unit), space heaters R314, R313 and R315 and STANDBY pilot lamp DS201 (in the Power Unit), and to the cathode heaters in the Tuning Unit front panel. [illegible] With the POWER switch in POWER position, a-c power is removed from the space heaters and the

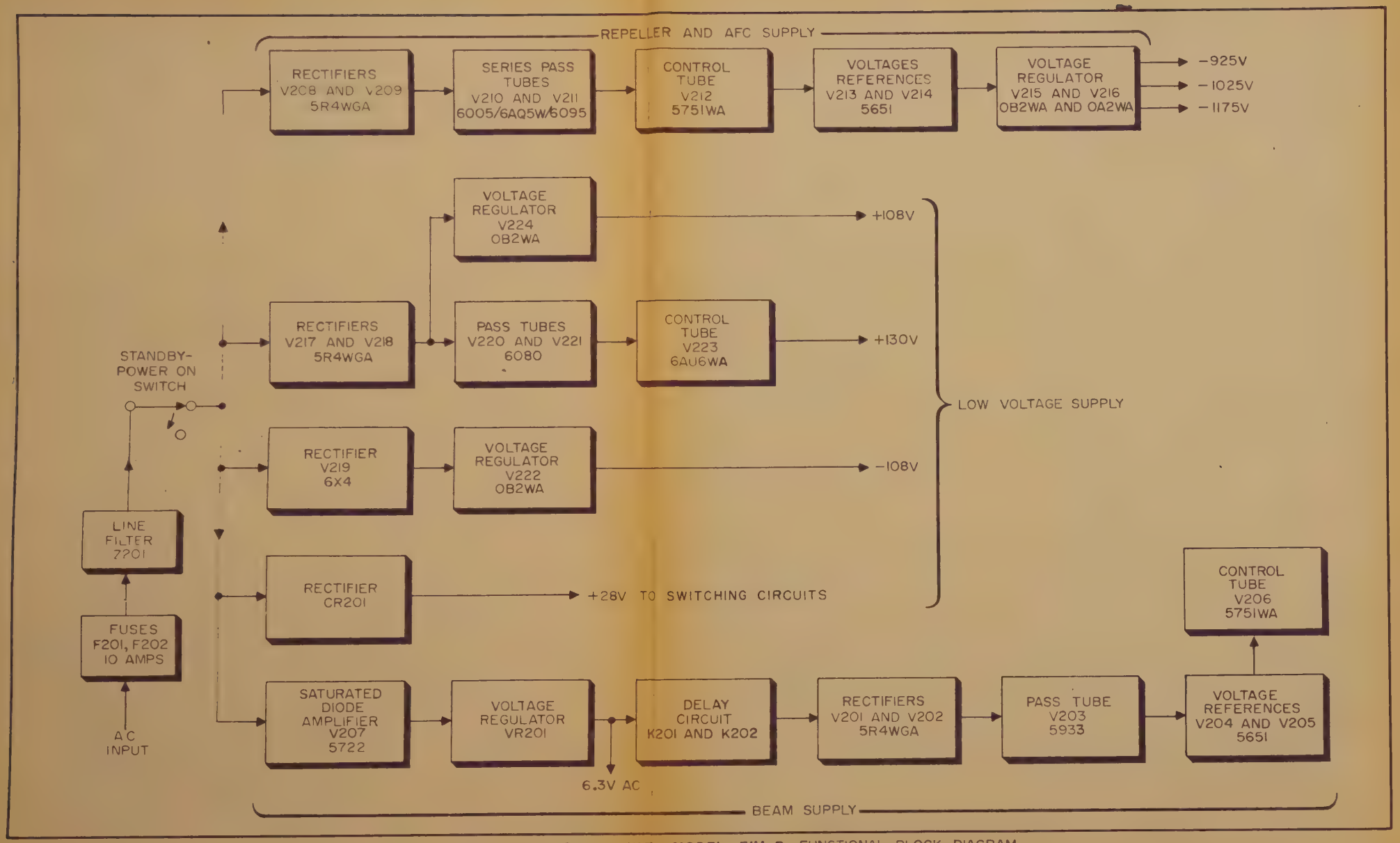


FIGURE 52. POWER UNIT, MODEL FIM-P, FUNCTIONAL BLOCK DIAGRAM.

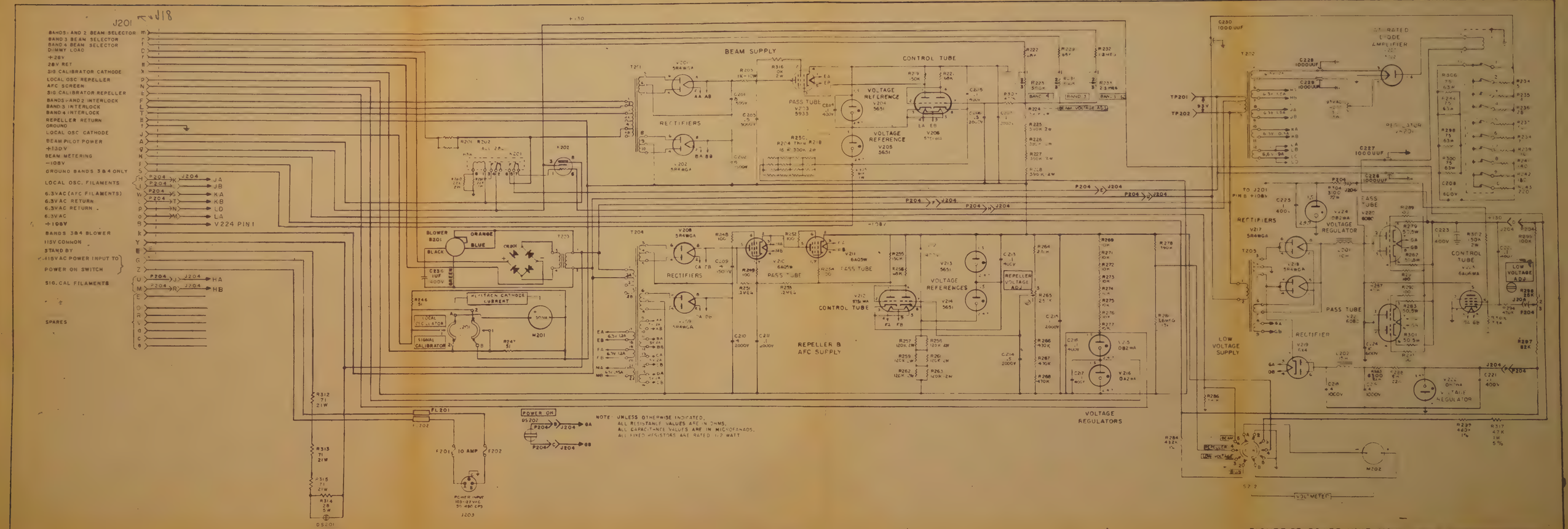


FIGURE 53. POWER UNIT, MODEL FIM-P, SCHEMATIC DIAGRAM

[illegible] pilot lamps. The nominal 115-volt a-c input power, is applied through receptacle J203 to the Power Unit. The following power supply components are [illegible]

(1) 28 VOLTS DC SUPPLY. Selenium rectifier CR201 develops 28 volts d-c power for energizing the various switching circuits in the Tuning Unit and Monitor Unit.

(2) TUBE HEATER SUPPLY. Power transformer T202 supplies 6.3 volts a-c heater power to all tubes in the equipment, and also to saturated diode amplifier V207. With the diode operating, the approximate positive 108-volt potential at the output of V207 is used to energize the coil of the [illegible] voltage-regulating device, VR2[illegible] A 6.3-volt tap (terminals 1 and 2) on the primary of transformer T202 is applied to the heater element of time delay relay K201, which withholds application of power to the beam supply.

(3) LOW VOLTAGE SUPPLY. Simultaneous with the application of input power to transformer T202 (and saturated diode amplifier V207), the low-voltage power supply transformer (T205) is energized. This circuit energizes the following supplies:

(a) A gaseous-tube (V222) voltage-regulated negative bias potential of [illegible] volts dc, which is applied to the voltage divider at the cathodes of vacuum-tube voltmeter stages V23-V24, as well as to SLIDEBACK control R111 in the Monitor Unit.

(b) A gaseous-tube (V224) voltage-regulated positive potential of 108 volts dc, which is applied to POWER MONITOR ZERO SET control R142 (in the Monitor Unit) and to the power monitor bridge circuit (in the Tuning Units).

(c) An electronically-regulated (V220, V221, and V223) positive potential of 130 volts dc, which is applied as plate and screen grid potential to all tubes in the Monitor Unit.

(4) REPELLER AND AFC SUPPLY. The primary of power transformer T204 is connected in parallel with T202 and T205. Therefore, throwing POWER switch, on the front panel of the Tuning Unit, to the POWER ON position also immediately energizes the repeller and afc supply (V208 through V216). This circuit is primarily an electronically-regulated supply in circuit design, but its negative output is so connected to the beam supply that the final repeller supply output voltage is the sum of both repeller and beam supplies. Negative potentials of 925 volts, 1,025 volts, and 1,175 volts are available at the output of the repeller and afc supply for application to the following circuits in the Tuning Unit:

(a) The repeller of the klystron local oscillator tube;

(b) The repeller of the klystron signal calibrator tube;

(c) The screen grid of the afc amplifier.

44. BEAM SUPPLY, CIRCUIT DESCRIPTION.

a. TIME DELAY CIRCUIT. After a delay of 60 seconds (during which time the heating element of the time delay is receiving 6.3 volts a-c power from a tap on the primary winding of power transformer T202), thermal contacts 3 and 5 of delay relay K202 close. This action permits the +120-volt output of the low voltage supply (at the cathodes of V220 and V221, figure 53) to be applied to the coil of holding relay K201. With K201 energized, the following circuit action then occurs:

(1) The left set of K201 contacts (as shown on figure 53) applies the -120-volt potential directly to the coil, bypassing relay K202 thermal contacts, pins 3 and 8.

(2) The right set of K201 contacts (as shown on figure 53) breaks the heater circuit (pins 1 and 6) of delay relay K202 so that the delay relay need not be energized during equipment operation. At the same time, one leg of the 115-volt a-c power at terminal 1 of power transformer T202 is connected (by K201 relay contact) to terminal 4 of beam supply transformer T201. It is only necessary to connect the second leg of the 115-volt a-c power source to transformer T201 in order to energize the beam supply. This action is accomplished as described in subparagraph b, below.

b. BEAM INTERLOCK, BAND 1 AND 2. References to the schematic diagrams of the Power Unit (figure 53), the Monitor Unit (figure 42), and to a typical Tuning Unit (such as Band 1, figure 38) should be made throughout the following discussion. Each of the Tuning Units is wired, through interlocking leads, so that the proper output of the beam supply is utilized for the particular klystron tubes employed as the local oscillator and as the signal calibrator.

(1) For example, reference to the Power Unit schematic (figure 53) shows that terminal 1 of beam supply transformer T201 is connected to pin F of receptacle J201, a multi-pin connector physically located at the rear of the Power Unit. The connector mounted at the rear of each Tuning Unit mates with receptacle J201. Reference to the Band 1 Tuning Unit schematic diagram shows that pin F of connector J438 is connected, by means of an internal jumper, to pin Y (designated COMMON) of J438.

(2) It is only necessary, at this point, to refer to the Monitor Unit schematic (figure 42) and observe that the corresponding pin V of Monitor Unit connector J18 is tied to the second leg of the 115-volt a-c input power source at one terminal of POWER switch S403. With S403 in the POWER ON position, this leg of the 115-volt a-c line is applied to terminal 1 of beam supply transformer T201. Since terminal 4 of transformer T201 has been connected to the first leg of the power line, the beam supply is energized across primary winding terminals 1 and 4 of T201, and proper output for the klystron tubes in Band 1 (as well as in Band 2) is developed in the circuit comprising tubes V201 through V206.

c. BEAM INTERLOCK, BAND 3. Reference to the Power Unit schematic diagram (figure 53) will show that taps are provided on the primary winding of beam supply transformer T201. When a Band 3 Tuning Unit is properly interconnected to the system, terminals 2 and 4 receive the input power and produce a higher step-up ratio for the input voltage to the beam supply. This action produces a higher final output (than in the case of a Tuning Unit covering Bands 1 or 2) of the beam supply for operation of the Band 3 Tuning Unit.

d. BEAM INTERLOCK, BAND 4. In similar fashion to that described in subparagraph c, above, refer to the Power Unit schematic (figure 53) and note that interconnection of a Band 4 Tuning Unit to the system will result in still a different circuit arrangement. In this case, the 115-volt line supply will be applied across terminals 3 and 4 of the beam supply transformer T201 primary winding.

As a result, a higher step-up turns ratio exists at the transformer, and higher output potentials (than required for previous Tuning Units) are produced for the operation of the Band 4 Tuning Unit.

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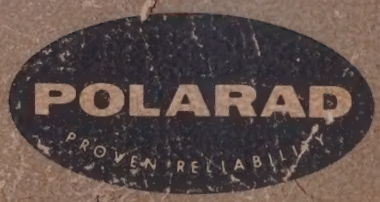

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